6

ANNUAL REPORT

FY 1971

ACME
COMPUTER for MEDICAL RESEARCH
STANFORD UNIVERSITY

ACME Computing Facility
Stanford University School of Medicine

Primary support from

Biotechnology Resources Branch,
National Institutes of Health

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INTRODUCTION

ACME, Advanced Computer for MEdical Research, is approaching the end of it's fifth year as a research and development facility. This report describes the accomplishments of the first nine months of the current fiscal year which ends July 31, 1971, and plans for FY1972. We find that we are starting a period of transition for two reasons. ACME was designed as a research support facility but now faces the task of reconciling the needs of computer science oriented research and public utility type timesharing services. During the coming year we must move toward supporting one of these functions on alternate hardware. In addition, ACME started to charge fee-for-services in March, 1969. We do not expect the user community to have adequate financial support to pay ACME's full costs by the end of FY1972. Therefore we are requesting a 15-month extension to the grant period to complete this critical period of transition. More development tasks have been identified for FY1972 than can be accomplished by existing staff and budget. A condensed list of tasks will be made in three to four months. We hope that ACME and N.I.H. can reach an agreement on the retention of income for use at Stanford by that time.

I. SUMMARY

A. Fiscal Year 1971 - In Retrospect

1. ACME System

The past year has been a very successful one in terms of improving general service levels for users of the ACME computing service. Our major accomplishments were in these areas:

- improved reliability
- long record handling
- implementation of LISP
- small machine support

One of our basic goals was to improve hardware reliability. The mean-time between failures for hardware increased by a factor of 4 in FY1971. The mean-time between failures for all unscheduled downtime increased by a factor of 2.5.

Another highlight of the year has been the announcement to users of new small machine assemblers. There are now over 40 small machine systems in the Stanford University Medical School. Most of these systems are Digital Equipment Corporation machines. The macro assemblers now handle PDP-8, PDP-11, and LINK Computers.

The extension of the file system to handle long records was a major accomplishment. Historically, ACME has had a fixed block length of 1968 bytes per record. With the new file system, records are spanned so that the new maximum record length is 65,535 bytes.

Another milestone has been the implementation of a LISP interpreter and LISP compiler under ACME.

The ACME systems staff also implemented a powerful graphics support package, an overlay system for various statistical subroutines to reduce the amount of core required by the system, and made many modifications to the communications software.

2. User Projects

Significant progress was made on the Drug Interaction Program being designed and developed to provide warnings to physicians whenever a prescription is likely to interact adversely with an earlier prescription given to a patient.

I. SUMMARY

A Clinical Laboratory Information System has gone through the development stage and is now ready for implementation. The DENDRAL research project staff became familiar with ACME and started to use the new LISP compiler under ACME. DENDRAL refers to the program which infers a structural hypothesis from mass spectral data.

We made some progress in shifting users to a paying basis for ACME services.

B. Fiscal Year 1972 - Looking Ahead

1. ACME System

Our major commitments are to maintain at least our present service levels and to move toward generating added revenue.

We are investigating three paths which will improve service and reduce our operating expenses.

- Retain stand-alone Medical School System.
- Move non-realtime computing to 360/67 and build front-end system for realtime users.
- Share facilities with the Hospital ADP Group.

The ACME staff is especially interested in providing additional support to small machine users throughout the medical community. The Stanford Medical School contains many small machines and the users of these devices have repeatedly expressed interest in more and better support for them. We also understand that the Biotechnology Resources Branch is interested in computer to computer communications networks. During the balance of this grant period, we will continue to improve the reliability of the existing system. ACME has been charging fee-for-service since March 1969. There has been little incentive to increase revenues since every dollar received in income reduces the grant by a comparable amount. In the coming year we will ask that income derived from fee-for-service be retained at Stanford to support biomedical computing activities, particularly extensions to ACME's core research activities.

2. User Projects

During fiscal year 1972, ACME will support:

- DENDRAL
- Drug Interaction Program
- Clinical Laboratory Instrumentation
- Other applications

Other applications will be considered as opportunities arise.

Charging rates for ACME services will be increased at varying intervals over the next two years. The goal of these changes is to eliminate the subsidy in the present rate structure so that ACME users will pay full cost recovery for the services received. In addition, a Cardiac Care Unit Monitoring System will be started if ACME's income can be used to support expanded core research activities.

C. Request for Grant Extension

In March 1969, ACME started to charge fee-for-service to the users. We hoped that by the end of the current three year grant period, ACME user income plus charges to ACME core research projects for computing service would equal total ACME operations cost. A 15 month extension is needed for two reasons: (1) ACME users need more time to obtain computing dollars in their budgets; and (2) the transition to alternate hardware requires more than the one year remaining in the existing grant.

D. Overview of Five-Year ACME Experiment

In 1966, ACME received a three-year grant from the Biotechnology Resouces Branch from NIH (then called the Special Research Resources Branch). The two goals were:

- Development of an on-line realtime data collection and control system.
- Development of a PL/ACME compiler that could be learned and used conveniently by medical staff.

In 1966 we decided that one large central resource could fill those requirements more effectively than multiple smaller systems in each of the laboratories. The experiment has been a great success. The PL/ACME compiler can indeed be learned and used very easily by the medical staff. It was the first known demonstration of an incremental compiler.

The outcome with respect to the realtime data collection user has not been similarly successful. ACME found that medical users require an extremely high degree of reliability which was most difficult to achieve with the large computing systems of the 1960's. Therefore, many users have acquired small machines which are capable of achieving very high reliability and can be dedicated to a single purpose. The economics of small machines looked far different back in 1965 when the ACME proposal was written. The rate of change in this field has been truly dramatic. Design of a realtime data collection system for today's environment might well involve a number of smaller processor's as dedicated systems, some of which need to be hooked to larger systems. Computing problems requiring many cycles but minimal core and other hardware, can best be handled by the mini or midi systems. However, the small computers are proving inadequate for a small subset of user programs, are becoming more complex, and need big machines. The next step entails a marriage of the small machine systems which have been developed in the early 1970's with new communications technology as well as more stable and reliable larger systems.

ACME is proud of what it has accomplished and has demonstrated an ability to cope with realtime data collection problems. ACME is nearing completion of the second year of a three year renewal grant. The primary problem addressed in the proposal for this renewal period was to make the ACME system more reliable. Although much has been accomplished to achieve this goal, limitations of system 360 hardware, complex software developed locally, and reliability requirements imposed by the medical profession indicate needs for future developments in this field.

PART I. ACME FACILITY DEVELOPMENT

II. ACME FACILITY ACCOMPLISHMENTS - FY1971

A. Software Modifications

1. Improvements in Reliability

A primary goal of the ACME staff has been to improve system reliability. The results of our effort may be seen in Table A which shows Mean Time Between Failures for the PL/ACME system on the 360/50 for FY1970 and FY1971. During that time MTBF for hardware-caused system failures and MTBF for all reasons, including hardware increased as follows:

MTBF	FY1970	FY1971
hardware caused	64.3	246.6
all reasons	34.4	84.8

Some of the specific steps taken to accomplish this goal are weekly meetings with IBM systems engineers and customer engineers, improved standards of cleanliness for the machine room, written procedures for ACME operators, and engineering changes from IBM. One major factor was a system modification which allows concurrent use by systems programmers and users during the evening shift. This gave the systems staff an experimental module without affecting the users. Prior to this, we had to mount new systems before they were completely debugged since there were very few times when we could dedicate the entire system to the software staff.

2. Long Length Records

File support routines were mofified so that a PL/ACME user can specify a logical record size greater than physical block size. A single READ or WRITE statement can reference up to 65k bytes of data. The size of physical blocks on disk has been kept at 2000 bytes.

3. LISP Compiler

An interpreter and compiler for LISP (List Processing Languages) was added. This in effect gives the ACME system a second language. To enter LISP mode as opposed to PL/ACME mode, the user includes a LISP keyword in his PROGRAM statement. LISP was implemented at the request of the DENDRAL research group, but may be used by any recognized user.

4. Small Machine Support

Assemblers

As we indicated in the Annual Report for last year, ACME implemented a small machine assembler program for PDP-8's and PDP-11's. This year it became operational and users may now write at an ACME terminal in PDP-8 or PDP-11 operation code. A PL/ACME program will assemble their code and print back diagnostics. When the program is debugged, a user can load it directly from ACME to the small machine via a 2701 port or a line through the 1800 processor without going through the paper tape or card phase.

Communications Package

A communications package has been written to handle communications between the Model 50 and smaller front-end machines such as the 1800 and PDP-11. One major change in the communication system was to adapt the code in the Model 50 to support the PDP-11 in the same manner as the 1800 is currently supported. Detailed plans have been made to modify the software in the Model 50 to permit non-2741 devices to log-on to the ACME system via the PDP-11. At present all log-ons must occur via the IBM 2702 transmission control unit.

Campus Computer Link

A link between ACME's PDP-11 and the Stanford Campus PDP-9 allows ACME users to exchange data with all departments of the University. By the end of the current fiscal year we will complete a project which allows programs and data to be transmitted from ACME disk storage to Campus disk storage and vice versa. An ACME user will be able to run production versions of jobs on the Campus 360/67 in batch mode and a user of the Stanford ORVYL system will be able to communicate directly with ACME and transfer data and program files.

5. Other Software Developments

Utilization Measurements

Several new utilization measurements have been developed. We now know the number of users per half hour interval for weekdays and weekends. Utilization data include the number of users excluding staff, core pages used for various types of use, number of realtime lines open, and maxima used during each half hour period including the ACME staff users.

II. ACME FACILITY ACCOMPLISHMENTS - FY1971

Translator

A PL/ACME to PL/1 program translator was completed. It is primarily intended to accommodate ACME users who wish to run production programs in batch mode at the Stanford Campus Facility. It also aids those who move to other Universities which support PL/1 batch service but not an interactive PL language.

Compiler Improvement

Several incremental compiler changes were implemented. PL/1 type formats were added to the PUT EDIT statement and a STRING option added to the GET and PUT statements. The user now has full capability of the GET and PUT statements and can format character strings.

In addition, other significant accomplishments this past year include:

- new public programs added, primarily statistical
- project and data set protection increased by use of keywords
- ACME data set to OS data set conversion
- overlay of ACME load module
- SYSGEN of OS Release 18
- support of new hardware: Hazeltine Model 2000 and Beehive Model 3 displays
Litton Model 30 printer

B. Hardware Modifications

1. Improvements in Reliability

Early in ACME's history we purchased special devices from IBM, identified as a 270X and four 270Y's. These devices were used for medium data rate acquisition for the realtime system. Unfortunately, this hardware never operated reliably and during the past year IBM repurchased it from Stanford University. This has been the biggest factor in increasing our hardware reliability. The new PDP-11 and existing 2701 Data Adapter have replaced some of the functions of this hardware. Part of the sale proceeds have been spent to design and build a special interface between ACME and the mass spectrometer. We have labeled this new device a 270Z interface.

2. Addition of PDP-11

The PDP-11 computing system acquired last summer has been installed and interfaced to the Model 50. At present the PDP-11 is being used to drive alphanumeric displays, a special printer, and a Sanders controller. The Sanders controller was originally driven by a 270Y. A PDP-11 disk has been ordered and will be delivered before the end of FY1971. This disk, which has approximately 2.4 megabytes of capacity, will be used for the Drug Interaction Program initially.

3. Addition of Displays and Printer

We added two Hazeltine Alphanumeric Displays and one Litton Printer for the Drug Interaction Program. The Hazeltines were replaced by Beehives because of problems experienced with shift keys. If one hit the shift key and an alphanumeric character, a spurious character resulted.

4. Modification of 1800

Four analog input ports and 8k of core were added to the 1800 processor. The additional core has permitted implementation of a new communications system and allowed users to store data directly on the 1800 disk whether or not the Model 50 was operating. The added analog input ports have increased the number of lines which can be handled simultaneously from 12 to 16.

5. Other Hardware Changes

<u>2314 Conversion</u>

ACME's 2314s will be converted to 2319s in the near future. This is a field modification which will reduce rent on the units by a few hundred dollars per month without changing any of the technical characteristics.

<u>Loma Linda Graphics Terminals</u>

Two of these terminals are to come to Stanford University in the month of May.

<u>User Interfaces</u>

Over the past year several interfaces between ACME and user realtime instrumentation have been designed and installed. Among these are interfaces to gas chromatographs, plotters, XY recorders, and other small machines such as PDP-11 and PDP-8.

C. User Services

The goals of the User Services Group of the ACME Project are to:

- offer individual and specialized help to the users
- train the user in the use of the ACME system
- make information about the use of changes to the ACME system readily and easily available

II. ACME FACILITY ACCOMPLISHMENTS - FY1971

For purposes of discussion, the function of the User Services Group will be divided into three activities; Consulting, Education and Documentation.

1. Consulting

The consulting staff consists of one part time member and three full time members. One full time member of the consulting group specialized in statistical problems, another in mathematical consulting. The other full time consultant and the part time consultant are available for more general problems. By the end of April, the latter two consultants will be relocated to an office recently constructed in the ACME machine room where they will be more accessible to users. All consulting staff members maintain a consulting activity log which allows them to follow-up and to spot problem trends. It is an important source of input to the ACME courses, the ACME manual, and the ACME system.

2. Education

ACME offers courses in the PL/ACME programming language and the use of the ACME system. An introductory course consisting of three 1-1/2 hour sessions is offered twice a month. Last year 189 members of the medical community attended these courses. A 4-1/2 hour advanced course for realtime users was offered 3 times last year. The total enrollment was 21. These courses have been and will continue to be modified by user needs and problems. Since we now have a LISP compiler, ACME is offering a LISP seminar. This is a 2 hour introduction to some of the fundamental concepts of LISP, as well as a description of applications best suited for LISP. The first such seminar had an enrollment of 26.

3. Documentation

NEWS

A publicly available program named NEWS is in the ACME system. This gives the user immediate notice of any changes to the ACME system or any other items of interest. The user may call this program, and by the use of appropriate "keywords" (e.g. PLOTTING), retrieve all information that is of particular interest to him.

Newsletter

ACME pulishes a Computing Newsletter on an as needed basis to inform users of:

- new programs and subroutines
- changes in ACME's operating schedule
- ACME course and seminar schedules

- new ACME documents
- changes in staff
- use of computers in medicine

PL/ACME Manual

The PL/ACME Manual is a complete reference manual, with a complete definition of the PL/ACME programming language, a detailed explanation of its usage, and extensive examples. A new 300 page addition was distributed in November, 1970. This year we plan to supplement the Manual with a thirty to forty page Primer. The PL/ACME Primer will teach the basics of the PL/ACME language using step-by-step lessons with simple examples.

4. User Tape Service Report

In May 1969, a tape dumping and restoring service was provided whereby a user could remove files from direct access storage when on-line retrieval was not required. Later the files may be copied back to disk.

Dumping is the process of moving a file from disk to tape; restoring is the inverse. The user always provides his own tape.

As of April 20, 1971, 214 individual requests for file dumps had been submitted. The requests came from 69 users; 31 requests from a single user; and 122 requests (57% of the total) from 11 users. 9,300 individual files have been dumped for a total of 268,150 blocks of 2000 characters. This volume is more than twice our disk capacity.

Restore records have been kept since April 1970. 92 requests were submitted for a total of 34,760 blocks covering 1028 files. 25 users have requested the service. One user of the 25 has asked for restores 27 times.

D. ACME Personnel

CURRENT DIRECT STAFF	Approximate FTE[1] At Present	Terminated During Past Year	% Time While At ACME
Principal Investigator			
Joshua Lederberg, Ph.D.	0		
Associate Principal Investigator			
Edward Feigenbaum, Ph.D.	0		
Director			
Ronald Jamtgaard	1		
Assistant Director			
L. Lee Hundley	1		
Consultant to the Director			
Gio Wiederhold	.35		
Systems Programmers			
Robert Berns	1	David Cummins	1
Russell Briggs	1	David Emerson	.4
Regina Frey	1	Serge Girardi	1
Charles Granieri	.4	David Gray	.4
Ying Lew	1	Ole Osterby	1
Stuart Miller	1	Ken Salisbury	1
		Donald Wilson	1
Applications Programmers			
Robert Bassett	1	Ray Liere	1
Linda Crouse	1		
Robert Hale	.5		
Gary Sanders	.2		
Jane Whitner	1		
Voy Wiederhold	.25		
Research Assistants			
William Berman	.5 (plus Computer Science Department related work at ACME)		

[1] FTE is defined as "full time equivalent".

II. ACME FACILITY ACCOMPLISHMENTS - FY1971

CURRENT DIRECT STAFF	Approximate FTE At Present	Terminated During Past Year	% Time While At ACME
Summer Student Help			
		Douglas Brotz	1
		Andrew Saal	1
Operations			
Charles Class (Manager)	1	Charles Sandoval	.2
Richard Cower	1	James Vantassel	.2
James Matous	1		
James Meek	.2		
James Rieman	.4		
Jan Sutter	1		
Lee Weatherby	.2		
Lee Whitely	.2		
Secretaries and Administrative Aides			
Madeline Aranda	1	Trammel Lonas	1
Lucinda Miller	1		

TOTAL ACME GRANT EFFORT (FTE)[2] 18.20

OTHER PERSONNEL INVOLVED

Policy Committee Members

Malcolm Bagshaw, M.D.
Robert Baldwin, Ph.D.
J. Weldon Bellville, M.D.
Byron William Brown, Jr., Ph.D.
Howard Cann, M.D.
Charles Dickens
Avram Goldstein, M.D.
Donald Harrison, M.D.
Courtney Jones
Burt Kopell, M.D.
Elliott Levinthal, Ph.D.

[2] Excludes summer student employees and those terminated during the year May 1, 1970 through April 30, 1971.

II. ACME FACILITY ACCOMPLISHMENT - FY1971

Policy Committee Members

Bruce Stocker, M.D.
Howard Sussman, M.D.
Jobst Von der Groeben, M.D.
John L. Wilson, M.D.

Business Manager

Robert Langle

E. ACME Organization

The principal investigator of ACME has in effect subcontracted to the Stanford Computation Center the tasks of developing, implementing, and operating PL/ACME. With the advice of the ACME Policy Committee, he has directed the research activities and given much policy guidance.

Since last September, the acting Director of the Stanford Computation Center (SCC) has been Charles Dickens. In addition to ACME, there is a Campus Facility and a Stanford Linear Accelerator Facility. The Director of each facility reports to Mr. Dickens. In recent months, SCC has taken steps away from this facility organization toward functional organization. As a result of this change, ACME systems programmers will be grouped with systems programmers from the Stanford Linear Accelerator Center and Campus Facility. Similarly, operations and user services functions will become functionally organized. We hope that this change will improve service to users.

Another group which has worked actively on the ACME project in the past year has been the User Charges Sub-Committee of the ACME Policy Committee. This group reviews requests for subsidized use of the ACME system and sets the Policy guidelines on such matters.

III. ACME'S FUTURE DIRECTION

A. The Transition Problem

1. Statement of the Problem

Two factors are forcing us to radically change the ACME Facility. The first is financial and the second is choosing to serve special research versus general computer users. The dollar problem is based upon estimates of income from fee-for-service over the next few years. ACME estimates that income from users will not equal the cost of providing PL/ACME services over the next two years. Income estimates amount to roughly two-thirds of the direct operating costs where such costs are estimated at $650,000. This level of operating costs includes maintenance and operating staff but no development work, and is based on rental rates of existing 360/50 hardware. Utilization of ACME is not the problem; ACME's users simply do not have adequate funds in their budgets to permit continuing current usage at full cost recovery rates. If the current level of usage could be maintained while charging competitive service rates, the resultant income would exceed costs.

The second problem involves the dichotomy between computing support for computer science oriented research versus "public utility" computing services for a broad community of users. Initially, ACME was a research facility developing new software and hardware for medical research users. We were successful in fostering a substantial community of users who are dependent upon ACME for stable, reliable services with high availability requirements. The computer-science researcher can no longer obtain the system for 24 hours of continuous use to test new concepts. Service goals have been given higher priority than research goals. This choice was fostered by the N.I.H. request to institute fee-for-service. In order to increase income, services had to become stablized.

The problem now is to find a cost effective means of providing PL/ACME type computing services to a community which has become dependent upon ACME. The current community does not have enough dollars to keep the existing system on a stand-alone basis. Three alternate paths appear to warrant further study:

1. Retain a stand-alone facility, by shifting to a smaller system or finding additional financial support; provide front-end processor for realtime users.

2. Move the time-sharing users to Stanford's 360/67 after mounting an interactive PL-language; fulfill realtime needs on a new front-end processor.

3. Share selected facilities between the Medical School, ACME and the Hospital Data Provessing Group.

Note that paths 1 and 2 both include front-end processors. The front-end system could be duplicated to provide one for normal realtime services and another for dedicated use by various research projects.

These and other paths will be studied over the next few months. Part of the investigation will include an analysis of the extent to which user files on disk are current and regularly used; what fraction of disk usage represents programs as opposed to data files; and dependence upon PL/ACME features. This information will be used to estimate the effort involved in any future conversion. After completing the various studies, we hope to have at least two years in which to design and implement the follow-on system. This assumes N.I.H. will approve the request for extension. A more detailed schedule including target dates for realtime and timesharing substitutes should be available by early Fall, 1971. The intervening studies will also provide answers to such questions as:

- How do service rates compare between ACME and Campus Facilities?
- What hardware alternatives really exist for replacement of the 360/50 in a stand-alone fashion? What changes would be required to mount PL/ACME on these?
- If a stand-alone system were added for computer science oriented medical research, what would be the marginal or incremental costs associated with non-realtime users? Could they help pay for the facilities without compromising research objectives?
- Should relationships with private companies be considered in which Stanford offers certain software (PL/ACME) in return for computing services?
- What is the minimum size hardware facility acceptable to large control programs for realtime research (such as DENDRAL)?
- How will computing networks influence the next generation of computing at Stanford?

The above list covers just a few of the questions to be considered by the faculty and Computation Center staff.

2. Discussion of Alternatives to be Explored

Three paths have been selected for discussion. Additional alternatives will be added as they arise.

a. Path 1: Retain a Stand-Alone Facility in the Medical School

The current ACME system is a stand-alone facility in the Medical School. This arrangement could be retained by current hardware or by a shift to alternate hardware such as an IBM 370/145. Two advantages of a stand-alone system are more direct control by the medical community and more flexibility to change than a larger service center with several thousand users. Three disadvantages are the relatively high fixed cost, the dichotomy in goals between research and service computing needs, and the inability to make convenient use of all the other computing services available on Campus.

IBM has recently announced a 370/145 system which, with 1 million bytes of high-speed core plus comparable amounts of disk storage and peripheral devices, could be rented for about $4,000 less per month than ACME is paying for the 360/50 system. The primary difference between these two configurations is that the current system has 2 million bytes of bulk core (8 microsecond) and 128k of 1 microsecond core. The 370/145 core would be faster than 1 microsecond. The current ACME system would not work well in the limited amount of core described here. However, it may be feasible to modify the ACME system so that 1 million bytes of high-speed core of the 370 system could handle the computing requirements of the Medical Center better than the current system. The technical requirements of shifting to this newer generation of hardware will be reviewed when we study the feasibility of retaining ACME as a stand-alone facility.

This path will become feasible if users in the STANFORD medical community can identify funding levels and sources adequate to cover the costs of operating a large system. A determination of potential fund availability will be made by late summer, 1971. Two types of operation could result. One is a service center providing time-sharing services with emphasis upon small machine support. Another is a research support system designed to support a limited number of research groups working in computer science related areas. The latter mode of operation could entail a relatively large system (370/145, PDP-10, etc.) requiring several research groups in order to provide adequate financing. To date attempts to identify a few (four to six) research groups which might each provide $100,000 or more per year for computer service have proven unfruitful. An estimate of $500,000 in annual income from service fees for operation as a service facility rather than a research facility appears in Section VI. One question to be resolved is whether additional income might be forthcoming from within ACME's user population.

b. Path 2: Move Timesharing to 360/67; Add Front-End Processor for Real-time Needs

Description of Stanford Campus Facility. Both ACME and Campus Facilities are part of the Stanford Computation Center. The Campus Facility operates a 360/67 with one million bytes of core, and serves approximately 3.000 persons in the Stanford community. It is located about 500 yards from the ACME machine room.

The Campus Facility supports approximately 20 languages in batch mode and three languages in timesharing mode. Services offered include a powerful text editor, express batch and production batch services, plotting, remote job entry, and the possibility of handling some special devices with a PDP-9.

At this time the Stanford Computation Center is merging toward a functional rather than a facility organization. As a result, ACME systems programmers are now grouped with systems programmers from the Campus Facility and the Stanford Linear Accelerator Center Facility. User services and operations personnel will soon be similarly organized.

Sketch of Work Entailed. Considerable study will be required to evaluate the work required to merge the ACME and Campus Facilities. The problem has been reviewed in a cursory fashion with the following results. PL/ACME offers two types of services: the first is timesharing and the second is realtime data collection and control.

The realtime data collection and process control functions would be moved to a smaller front-end machine. Current thinking is that the front-end processor would have 75 million bytes of disk storage attached to it and be capable of handling data rates faster than the ACME system now does.

The timesharing portion of ACME service would be transferred to ORVYL, the timesharing monitor of the Campus Facility. This would be done by writing a new compiler under ORVYL but several segments of this compiler could probably be copied directly from the current ACME system.

An initial review of the task indicates that two to four man-years of effort might be required to mount an interactive PL/1 subset under ORVYL. It is essential that the transition to any alternative system be made with minimum changes to ACME users. Some of the options currently being reviewed include the mounting of PL/C, the PL/1 supported under IBM's TSO, or a revised form of PL/ACME. The ability of the ORVYL monitor to handle its present load plus the PL/ACME load is also being studied. At the present time, we can merely indicate that one potential path for ACME's future is to merge with Campus Facility and reduce the fixed cost of a large hardware installation while providing comparable levels of service.

The realtime data collection and process control front-end machine would be designed for high reliability and availability. It would serve a number of users and provide access to large disk storage devices on the central facility. One potential method of fulfilling the needs of the more computer science oriented research groups would be duplicating the front-end processor. This concept offers the advantages of using software developed for the realtime users, having redundancy in the hardware and software portions of the systems, and providing the experimental groups with access to the central facility. This idea also applies to Path 1.

c. Path 3: Sharing of Facilities Between ACME and Hospital ADP Group

The Stanford Medical Center consists of a Medical School, Hospital, and Clinics. More than half of the house staff of the Stanford Hospital hold faculty appointments within the Stanford Medical School. Many of these same persons provide medical services through the Stanford Outpatient Clinic. The Hospital Administrative Data Processing Group is now operating an IBM Model 30 system and plans to install a Model 40 system sometime soon. Path three calls for sharing computing facilities between ACME and the Hospital Administrative Data Processing Group.

Recently, the Hospital and ACME Computing groups prepared a joint report on the feasibility of linking the disk storage of the two systems together. The administration of the Hospital and Medical School are currently considering this report. As the Hospital moves toward terminal-oriented services, an opportunity of sharing communications systems will develop. Similarly, the future sharing of hardware, personnel, training, software systems, and other resources may become desirable and practical. It is premature to indicate the extent and degree of the future integration of these facilities but additional cooperative ventures may be encouraged by improved definition of ACME's future role in the Stanford Medical Center.

From ACME's viewpoint the Hospital ADP Facility will continue to fulfill the non-realtime needs of the administration. Terminal services will be implemented to drive hospital information systems. ACME's role in the hospital, as distinct from the medical school, will be the realtime aspects of intensive care and cardiac care unit monitoring and future areas of physiological monitoring. In addition, ACME will consider the role to be played by small machines in future hospital care and attempt to relate its small machine support to these functions. In addition, ACME will continue to provide the advantages of convenience, prompt response, numerous and meaningful diagnostic messages, and powerful language attributes to developers of new programs.

3. Goal: Model System for Biomedical Computing

Whichever of the paths discussed in the previous section is selected, the future systems should offer the following services. All are technically feasible with the current state of the art.

a. Realtime Capability

The facility should provide realtime data acquisition for researchers who do not choose to purchase their own mini-computer. At least 16 analog/digital lines of input or output should be planned initially with a capacity to be expanded to 64 lines. The aggregate data rate should be at least a factor of 10 greater than the existing 1800 system. Individual users have already expressed a need for 40,000 samples per second (one sample is equivalent to 16 bits). Several individual lines should be capable of handling up to 50,000 samples per second. Burst loads of 125,000 samples per second should also be allowed.

b. Interactive/Batch Environment

Both interactive and production computing are necessary. Interactive computing is desirable in the development and checkout phases of a program. It is also necessary for certain types of applications where the experimentor requires manipulative access to his data bank over extended periods of time. Other programs, after they have been developed, might execute better in a batch environment. These include statistical analysis and report generation of large quantities of data. Continued on-line computing also requires enhancement of the text editing facilities of ACME.

c. Language Considerations

The system should be easy to use. Users are specialists in their own fields and should be able to use the computer facilities without becoming expert programmers. The current philosophy of providing a relatively simple computing language and filing capability should be maintained. The Medical Center users currently program in the PL/ACME language. A well-defined language, perhaps nearly identical to the current language from the user's viewpoint, is required. PL/ACME is a non-proper subset of PL/1. If it were redefined to more closely resemble a proper subset of PL/1, the researcher could easily specify whether his program should execute in an interactive environment or in production batch under PL/1. The high level language should also be able to produce assembly code for a selected number of computers. Specifically, it should support compilation of assembly code for the user's small machine.

d. Small Machine Support

Small machine support requires convenient networking capability. Software and hardware must be available for communication between the mini-computer and the central facility. For example, a researcher might want to use his mini's console teletype for requesting services from the central computer. The results could be shipped back to the mini and placed on an output device such as a plotter, display, or magnetic tape.

A library of software packages for execution in the small machine is desirable. These programs could be written for specific functions such as communication with the central facility and for device handling.

Access to the central facility must be on-line and from a number of device types. In addition to the current 2741 typewriter terminals, access should be possible from other devices such as alphanumeric displays and the user's own computer. Thus the concept of networking should be carefully designed and incorporated into the system.

e. Access to Storage

Easy access to a large data base is of paramount importance. Storage capabilities should be at least as large as the current filing capacity (466 million bytes). Concentration on reliability of the files will guarantee that the user's data is secure from destruction. At the same time realtime data acquisition requires a data rate to direct access devices that is double the current rate, i.e., from 10,000 to 20,000 characters per second.

Security of medical data demands that a filing system be reliable and include guarantees against unauthorized access.

Software and hardware features are available for access protection and must be included in any redesign.

Since the cost of fast direct access devices is high, the system should provide a simple procedure for removing data to an off-line device such as magnetic tape or tape cassette when it is no longer needed for on-line access and for copying it back to the direct access device.

f. Graphics

Graphic support must be available through the central processor and the user's mini-computer. Generalized support of a large number of devices does not appear to be required. Rather, specific applications should dictate what graphics support should be included.

g. System Measurement

No system should be implemented without designed-in measurement and evaluation tools. A future system should incorporate evaluation aids for determining such measurements as performance, usage of the various components, and measurement of user programs.

h. User Support

The central facility staff should not be isolated from the user's application. Management and programmers should be actively involved with the users of the system they have provided. Such involvement can include preparing project proposals, selecting and installing hardware, designing the user's program and in some situations, loaning staff for implementation of the user's system. In any case, staff consultation should be readily available for solutions to user problems.

i. Reliability and Availability

From ACME's experience we find that the user community has extremely high reliability and availability requirements. We see as a possible solution a host of small machines dedicated to on-line tasks with a large system providing backup. Because of these requirements we have put such emphasis on small machines in the foregoing discussion.

B. Extensions to PL/ACME Services

1. Funding Priority

Various extensions and additions to PL/ACME services are listed in the following two sections. Although we would like to do all of them during the coming year, we cannot because of financial limitations. Top priority must go to the aforementioned transition studies and implementation. Therefore, only some of the PL/ACME changes described below will be realized in FY1972.

2. New Services

a. Small Machine Equipment Pool

ACME proposes to acquire a small machine equipment pool for users throughout the Medical Center. The purpose of the pool would be to let research teams use small machines for limited periods of time. Wherever possible ACME would charge the user an appropriate fee for use of the hardware. If the work is closely identified with the core research activities of ACME there would be no charge. The primary assumption behind this request is that a limited number of identical small machines and peripheral units would provide flexibility for various types of experimental set-ups. For example, one experiment may require 4k of core and a small disk unit whereas another experiment could entail 12k of core and a tape unit. If these units are available within ACME, it may be possible to avoid having separate systems for every research group and may promote a far more efficient use of computing hardware. One idea to be explored in this area would be contributions to the equipment pool of small machine systems which are presently being used very little.

b. Investigation of National Networks

We understand that the Biotechnology Resources Branch is interested in determining the relevance of National Networks of Computers to the Health Care field. The Artificial Intelligence Laboratory at Stanford has participated in such a network. This local experience in the field coupled with the professional staff at ACME puts us in a good position to study the applicability of network computing to medical problems. If N.I.H. is interested in early evaluation of network techniques, Stanford would propose joining a network or establishing a link with a remote university site. The budget request for the coming fiscal year does not include any funds for the kind of hardware presently manufactured by Bolt, Baranek and

Newman (IMP and TIP). However, the ACME staff will be alert to potential applications that could utilize such a linkage. In addition, early in FY1972, we will weigh the advantages of being associated with a local or national network if N.I.H. wants to pursue the subject. Comments of the Biotechnology Resources Branch are invited.

3. Extensions to Existing Services

a. Support for Small Machines

Included in this area are:

- macro-assemblers for small machines other than the PDP-8, PDP-11, and LINK.
- simulator for small machines in ACME.
- utilities for loading small machines connected to the system and handling tape I/O, etc.
- user support: a collection of a small machine code library to be shared by users; documentation on small machine projects; development of standard interface hardware for connecting various small machines to larger systems on Campus.
- study of the feasibility of operating a library of small machines and peripherals.
- small machine compiler: a small machine compiler should be written in PL/ACME or some high-level language to permit users to program their small machines in a subset of PL/ACME. It would be desirable to some day incorporate into this compiler a model of the small machine parameters for each user. This would permit the large machine to determine which functions would be done in the large machine and which in the small. The large machine would also compile code for the small computer.

b. Compiler Improvements

Extensions to the PL/ACME compiler are planned in two specific areas; text editing and information retrieval.

Two or three commands, probably "move", "change", and "copy" will be added for text editing.

Information Retrieval

A limited information retrieval capability will be added. The ACME file system is well organized to accommodate certain information retrieval projects. In fact, several ACME users have written their own. Since the data bases have been established independently, the result is a variety of data base designs and a duplication of information and retrieval methods. A future system should include a unified patient data base, serving all patient care and related research programs of the Stanford Hospital and Medical School. The data base structure might be designed as a master file of common patient elements and a number of subfiles for information unique to a medical descipline. Retrieval might be along commonly used paths of the data base structure or it may be unpredictable. That is, the questions cannot be determined in advance. Consequently, the retrieval mechanism should honor both predetermined and unpredictable requests. One implementation scheme would incorporate the generalities of the PL/ACME language with new commands for executing predefined functions.

c. Realtime Data Collection

ACME service in this area was a pioneering effort at the time it was implemented. For today's technology, ACME's data rate capability is low and incapable of handling many applications. The 1800 can accomodate an aggregate of only 10,000 samples per second, and many users claim difficulty whenever aggregate data rates exceed 2,500 samples per second. Users must obtain realtime input/output lines from an ACME operator. This service should be automated. The 1800 is used only as a traffic control device and not for any pre-processing of data. The Model 50's bulk core is 8 microsecond core and this is a fundamental limitation in the speed of the system. One user in Nuclear Medicine recently proposed purchase of a dedicated small machine with disk and tape peripherals to handle bursts of 40,000 samples per second. The role of the "smart" or HIQ terminals applies to this realtime data collection requirement. ACME must determine the best way to meet the need for this type of service. A small machine pool may be a solution, especially if a few of these units can be equipped with disk and/or tape.

4. I/O Devices

Voice Drum. A private corporation gave Stanford one voice drum. We are eager to find a potential user of the voice drum so that we can work with him to develop this hardware. The drum has a limited vocabulary of 50 words. The hardware interfacing the voice drum to the PDP-11 should be finished by the end of the current fiscal year. We anticipate using voice output for a warning system or in other situations to call attention to a typewriter or graphics terminal.

Tape Cassette. We would like to explore the use of the tape cassette for storage of user data. Users might find that tape cassettes could replace disk storage for many applications. We would like to make it possible for the user to enter data on line, analyze it to some extent, record it on tape cassettes, and retrieve it for future analysis as needed. The potential reliability added by collecting all data on tape cassette at the time of data input is also significant.

Alphanumeric Displays. The alphanumeric displays added to ACME for the Drug Interaction Program during this past year have been interfaced to the PDP-11 which in turn has been interfaced to the 360/50. ACME software has been and is being modified to better support these devices. For a significant number of ACME users (10-20) alphanumeric displays would be better than the current 2741 typewriter terminals because they are quieter, offer one page at a time rather than one line at a time, and are very convenient especially for fixed formats of data entry. We consider special support for this type of hardware highly desirable. Such support may include new commands for handling full pages of data and revise editing features, and other commands designed to take advantage of the 2-dimensional nature of CRT's.

PART II. ACME USER DEVELOPMENTS

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

A. Core Research Descriptions

During the past year ACME has identified several user projects which we consider core research application work under the ACME grant. One specific example is Dr. Stanley Cohen's drug interaction project. For this project ACME pays for the computing services including some of the programming effort.

Another kind of core research application consists of Dr. Lederberg and Dr. Feigenbaum's DENDRAL project. The DENDRAL project intends to pay for its computing services according to the grant request, but ACME will support new systems work specifically for DENDRAL.

A third type of core research is one in which ACME pays for all computing services and the user pays for all other associated costs. The projects of Dr. Bellville (G_SWANSO.THESIS) and Dr. Sussman fall into this category. Dr. Sussman developed a Clinical Laboratory Information System on ACME. When development was complete, he requested financial support from the Hospital for its operation. Therefore, the LABSYS project has been completed as a core research task.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Cross Reference Core Research Table

Principal Investigator	Project	ACME User	Pageminutes	File Storage	Project Description Page
Bellville, J.	THESIS	Swanson, G.	770,609	27,342	31
Cohen, S.	DRUGALRT	Cohen, S.	492,858	20,141	32
Feigenbaum, E. Lederberg, J. Djerassi, C.	DENDRAL	Reynolds, W.	55,220	300	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	DENDRAL	Ross, R.	128,176	2,125	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	DENDRAL	Stefik, M.	216,957	2,088	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	DENDRAL	Stillman, R.	88,896	400	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	DREAMS	Reynolds, W.	346,971	18,445	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	DREAMS	Stillman, R.	199,650	10,430	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	CHEM	Ross, R.	633,855	15,123	33-36
Feigenbaum, E. Lederberg, J. Djerassi, C.	GAME	Bacon, V.	1,030,239	32,850	37
Sussman, H.	LABSYS	Sussman, H.	43,083	182	38
Sussman, H.	LABENG	Sussman, H.	924	9	39

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Respiratory Studies

Name: Swanson, G. (P.I.: Bellville, W.) Project: THESIS

Department: Anesthesia

Project Description: The precise interpretation of the drug action mechanism on the human respiratory system is critically important for the evaluation of new pain relieving drugs. The improvement of analgesics and antagonists depends in part on the precision and specificity of this interpretation. The classical experimental methods are restricted to assessing drugs in terms of an integrated respiratory effect. One method of improving the specificity is to model the respiratory system mathematically and interpret a drug effect as a parameter change. This project involves the development of an experimental computer-aided instrumentation system for accumulating and interpreting human respiratory response data in terms of a mathematical model. The model quantifies the function of the peripheral and central chemoreceptors, and the effect of oxygen tension on carbon dioxide response. A parameter estimation scheme estimates the model parameters from input-output respiratory data. The model input (experimental end-tidal CO_2-O_2 time history) can be specified to minimize the uncertainty in a parameter estimate.

The system incorporates three important features: (1) An on-line hybrid computing system for real-time data acquisition of human respiratory CO_2 response data, (2) A digitally-controlled breathing chamber in which the computer dictates the subject's inspired CO_2 concentration for the course of an experiment, and (3) A digitally-controlled breathing trainer to study the subject's voluntary interaction with his involuntray CO_2 response.

The digital computer dictates the subject's inspired CO_2 concentration for the course of an experiment. This flexibility allows us to design the dynamic variation in end-tidal CO_2 so that the experiment yields specific information about the properties of the human CO_2 regulator.

The digital computer also controls a device which generates a sound very similar to human breath sounds. By having a subject listen to this device and try to duplicate the breathing pattern being dictated by the computer, we can study the subject's voluntary interaction with his involuntary CO_2 response.

This system is presently in use in ongoing studies of the normal and drug-altered respiratory control system. A suggested application of this system is to improve dose-effect sensitivity and drug-effect specificity. Another application of the system could be for the study of exercise physiology.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Drug Interaction Program

Name: Cohen, S. Project: DRUGALRT

Department: Clinical Pharmacology

Project Description: The project involves the establishment of a computer-based program aimed at preventing undesirable drug interactions and reducing drug toxicity at the Stanford University Medical Center. A data bank dealing with drug interactions of clinical significance will be compiled utilizing already available information present in the pharmacological literature. When prescriptions are filled by the Stanford pharmacists, the pharmacists will type the name of the drug and the dosage regimen into a terminal located in the Hospital pharmacy. When a new drug added to a patient's regimen interacts with any one of the several drugs the patient may already be receiving, the computer will print out an appropriate drug interaction alert accompanied by a literature reference, which will then be sent to the nursing unit by the pharmacist -- together with the drug. Prior to administering a drug accompanied by such an "alert", the nurse will contact the physician in charge, who will retain the prerogative of deciding whether or not the drug should be administered. This program will provide considerable teaching benefits to students and house staff, in addition to providing benefits of major importance to patient care. In addition, it will be possible to assess the impact of providing physicians with drug interaction information, and also to learn in a prospective way about the clinical consequences of drug interactions.

To date, a major part of data acquisition and programming has been completed. It is expected that the program will be operational on a trial basis during the next several months (April, May 1971).

In the future, it is anticipated that the program will be extended to other hospitals, and perhaps to non-hospital pharmacies in nearby communities. It is also expected that the program will interface with the laboratory test program which has recently been developed by Dr. Howard Sussman. Once this interface has been accomplished, it will be possible to utilize laboratory information in providing drug interaction alerts, and also to utilize prescription information in evaluating laboratory test results. Thus, laboratory evidence of inadequate renal function might serve to alert the physician not to administer usual doses of a drug that is excreted entirely by the kidney. Conversely, the artifactual effects of certain drugs on laboratory test results can be detected and appropriate warnings provided in the clinical laboratory.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

DENDRAL

Name: Reynolds, W., Ross, R., Stefik, M., and Stillman, R. (P.I.: Feigenbaum, E., Lederberg, J. and Djerassi, C.)

Project: DENDRAL

Department: Chemistry and Genetics

Project Description: The DENDRAL project involves collaboration between the Instrumentation Research Laboratory operating under NASA grant NGR-05-020-004, investigators operating under NIH grant GM 00612-01, and ACME.

The emphasis of the DENDRAL-ACME efforts is computer science while that of IRL-ACME endeavors are data acquisition and computer-instrument control.

The DENDRAL project aims at emulating in a computer program the inductive behavior of the scientist in an important but sharply limited area of science, organic chemistry. Most of the work is addressed to the following problem: Given the data of the mass spectrum of an unknown compound, induce a workable number of plausible solutions, that is, a small list of candidate molecular structures. In order to complete the task, the DENDRAL program then deduces the mass spectrum predicted by the theory of mass spectrometry for each of the candidates, and selects the most productive hypothesis, i.e., the structure whose predicted spectrum most closely matches the data.

The project has designed, engineered, and demonstrated a computer program that manifests many aspects of human problem-solving techniques. It also works faster than human intelligence in solving problems chosen from an appropriately limited domain of types of compounds, as illustrated in the cited publications.

Some of the essential features of the DENDRAL program include:

- Conceptualizing organic chemistry in terms of topological graph theory, i.e., a general theory of ways of combining atoms.

- Embodying this approach in an exhaustive HYPOTHESIS GENERATOR. This is a program which is capable, in principle, of "imagining" every conceivable molecular structure.

- Organizing the GENERATOR so that it avoids duplication and irrelevancy, and moves from structure to structure in an orderly and predictable way.

The key concept is that induction becomes a process of efficient selection from the domain of all possible structures. Heuristic search and evaluation is used to implement this "efficient selection".

Most of the ingenuity in the program is devoted to heuristic modifications of the GENERATOR. Some of these modifications result in early pruning of unproductive or implausible branches of the search tree. Other modifications require that the program consult the data for cues (pattern analysis) that can be used by the GENERATOR as a plan for a more effective order of priorities during hypothesis generation. The program incorporates a memory of solved sub-problems that can be consulted to look up a result rather than compute it over and over again. The program is aimed at facilitating the entry of new ideas by the chemist when discrepancies are perceived between the actual functioning of the program and his expectation of it.

The DENDRAL research effort has continued to develop along several dimensions during this period. The mass spectra of some previously uninvestigated compounds were recorded. The computer program has been extended to analyze the mass spectra of a more complex class of compounds, using new kinds of data. The artificial intelligence work on theory formation and program generality has also progressed.

Many mass spectra were taken to gather more data for the DENDRAL Program. The analysis of the mass spectra of carbamates and methoxyoximes provided general mass spectrometry rules for the computer program. The spectra of many steroids were taken to elucidate the mass spectrometry of steroids and to provide data for a problem area new to DENDRAL.

The steroid problem is new in several respects: First, in working with steroids, the program deals with much more complex molecules than ever before; second, the computer program uses element maps from high resolution data to resolve ambiguities; and third, the program uses metastable peaks to determine parent-daughter relationships between ions and thus to distinguish molecular ions and their primary fragments. Programming for the preliminary analysis of steroid spectra is nearing completion, and will be useful in the laboratory even though the complete computer program for analyses of this complexity has not been finished.

The artificial intelligence interests of the DENDRAL group are reflected in recent work in program generality, partly described in reference (A), and in the program we call meta-DENDRAL described in reference (C), which will infer mass spectrometry rules from collections of data. Parts of the meta-DENDRAL program have been written which codify observations about mass spectrometry, and work has started on the succeeding phase of the program which will generalize these observations into tentative rules.

A. Feigenbaum, E.A., Buchanan, B.G., and Lederberg, J. "On Generality and Problem Solving: A Case Study Using the DENDRAL Program", in Machine Intelligence 6, B. Meltzer and D. Michie (eds), Edinburgh University Press, 1971.

B. Buchanan, G. and Lederberg, J. "The Heuristic DENDRAL Program for Explaining Empirical Data", to be presented at the 1971 Congress of the International Federation of Information Processing Society (August, 1971) and published by North Holland Publishing Co. (in press).

C. Buchanan, G., Feigenbaum, E.A., and Lederberg, J. "Beyond Heuristic DENDRAL", to be presented at the International Joint Conference on Artificial Intelligence (September, 1971) and published in the Proceedings.

An evaluation of new high performance mass spectrometers was carried out to plan new instrumentation for this program.

This system plans to incorporate a high degree of computer control. The goal of the instrumentation project will be to combine the analysis of the DENDRAL computer program with the data acquisition and control capability of the computer. It is planned to do a fast preliminary data acquisition, let the DENDRAL program determine what additional data and data mode is desirable, have the computer control the instrument mode and data scan, and return the pertinent data to the DENDRAL program. Further iterations of this cycle can be repeated as long as the sample persists.

It is planned to connect a GLC (gas chromatograph) to the inlet of the mass spectrometer. The persistence of a given sample is determined by the duration of a GLC peak, a few seconds to a very few minutes. The mass spectrometer of the kind we are considering could usefully take data in many modes; low, high, ultra-high resolution and meta stables, high or low ionization potential, etc. It cannot acquire all this data in the time span allowed by a single GLC peak. Hence it is required that the computer determine, during the limited sampling time the most useful mode of operation, and then implement this optimum mode.

Dispersed Computer System for Instrumentation-HIQ Terminal:

The project for development of dispersed computers is the HIQ (High IQ) terminal project being carried out in collaboration with Professor Melvin Schwartz of the Physics Department, with joint NASA support and Air Force support under contract AF F 44620 67C 0070. Professor Schwartz's interest concerned a Direct Memory Access (DMA) for a PDP-11. This forms an important portion of our "HIQ" terminal concept. This terminal development will provide the instrument-computer interface for the DENDRAL project.

The HIQ terminal is the result of an experience in connecting scientific instruments to various computers and the current supply of powerful but economical mini-computers. These computers have desirable attributes for dedicated real-time instrument interaction. However, when used alone they can require costly software developments. Current time-shared computers such as ACME have very efficient programming generating capabilities. In the present configuration the HIQ terminal utilizes a PDP-11 mini-computer. The mini-computer is tied to the ACME time-shared computer. The system facilities for the mini-computer will lie wholly in the larger time-shared computer: program manuscript editing, compiling or assembly, and the handling of files. All these functions benefit by the programming efficiency of the larger computer. In addition the time-shared computer replaces local tape and disc units.

By the end of 1970 the prototype HIQ using the PDP-11 as a Local Processing Unit was connected to ACME via our existing data lines. Program writing, code assembly, and a degree of control by ACME, the time-shared computer, has been achieved.

Next in development will be the use of the HIQ to preprocess data from the existing mass spectrometer data channels in our Chemistry Department (DENDRAL). After that we will integrate the Direct Memory Access (DMA) unit for use with the next generation of mass spectrometers, develop telephone line communication, and other "front end" modules.

Note: The following names and projects are associated with the DENDRAL project: W_REYNOL.DREAMS, W_REYNOL.DENDRAL, R_ROSS.CHEM, R_ROSS.DENDRAL, M_STEFIK.DENDRAL, R_STILLM.DREAMS, and R_STILLM.DENDRAL. They appear under categories 5 and 6 in the "Summary of Resource Usage Table".

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Mass Spectrometry

Name: Duffield, A. and Lederberg, J. (see Bacon, V. on Summary of Resource Usage table) — Project: GAME

Department: Genetics

Project Description: This project involves data analysis from a Finnigan 1015 mass spectrometer. In this on-line project, the decision-making capabilities of the computer are coupled with those of an operator to direct the operation of a Finnigan 1015 quadrupole mass spectrometer.

The computer is used to actively direct the operation of the mass spectrometer by controlling the mass filtering system of the instrument. It is used to recognize and control the voltage changes which define mass peaks and enable the rapid collection and presentation of data.

The computer traces out peak shapes of the known masses in a reference gas, allowing the operator to determine correct mass positions and to enter any shifts in calibration into the computer register for compensation automatically.

While taking data, the information may be displayed on an oscilloscope or recorded on magnetic tape. Once data is acquired, the structural identification of organic compounds is made from orthogonal coordinate or spiral base plots of mass spectra made by computer direction of a calcomp plotter. The system is also used to analyze gas liquid chromatograph effluent, permitting the structural identification of mixtures of organic compounds.

Stored data offer the future possibility of spectra matching of unknown compounds.

It is being applied to problems supported by both NIH Grant AM 12797-01 and NASA Grant NGR-05-020-004. Useful applications have been in the determination of optical purity of alcohols, ketones, phenylacetic acids and phenoxypropionic acids. This analytical technique has also been used to determine the absolute configuration of alloisoleucine present in the serum of a patient suffering from "Maple Syrup Urine disease". In addition chemical methods are being developed for the analysis of the basic and acidic constituents of urine. The bases are present in far smaller amounts than are the acids and the isolation of the former requires maximum sensitivity from the gas chromatography-mass spectrometry system. The computerization of this instrumentation aids in both the data collection and analysis.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Clinical Laboratory Information System

Name: Sussman, H. Project: LABSYS

Department: Pathology

Project Description: A computer-based laboratory information system has been established at the Stanford University Medical Center. It is a modern system of handling the data flow in the clinical laboratories and has been developed on the ACME facility. Specific objectives of the system are to:

1) Reduce human errors;
2) Insure that processed data is available at a certain time each day;
3) Implement self-checking routines for monitoring accuracy of test results and to flag results that are beyond normal range;
4) Reduce bookkeeping and clerical work costs;
5) Provide wider distribution of data;
6) Improve procedural work flows as a step towards establishing a systems-oriented laboratory.

To date, the laboratory information system that has been developed handles the following functions of the clinical laboratory:

1) Ordering and processing of requests;
2) Accessioning of specimens into the laboratory;
3) Processing specimens within the laboratory for test analyses;
4) Recording test results both within the laboratory and externally.

All data is entered into the system by optical mark cards through a Hewlett Packard 21-2761B optical mark sense reader. These cards include cards to request that services be performed by the laboratory, cards to indicate the disposition of specimens within the laboratory, and cards to enter test results. ACME is used to control the process and report back information to the laboratory.

The first pilot study was conducted in the intensive care unit at the Stanford Medical Center. The logic of the system was tested and the operational commitments of the various staffs were determined. A current pilot study is being conducted using the entire Hoover Pavillion as a test model. In the next few months the gains of the automated laboratory system will be evaluated over the present manual system. The study is designed to allow an operations research type study of all transactions between the Hospital and the laboratory.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Name: Sussman, H. Project: LABENG

Department: Pathology

Project Description: Four Electrical Engineering students are connecting one of the large instruments in the clinical laboratory to the IBM 1800 for data collection.

This project will further the establishment of a modern system of handling the data flow in the clinical laboratory. The software for such a system is largely developed using ACME, with test results being entered by means of cards.

A direct connection to the 1800 will enable results to be entered into the system without the high probability of error inherent in transcribing results onto cards.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

B. Major Users

Listed in alphabetic order by Principal Investigator are descriptions of a few of ACME's major user projects. Additional descriptions of projects using ACME are presented in Part IV of this report. All of the projects described here are charged for all of their use of ACME services.

The Biotechnology Resources Branch requested that the current year annual report include more descriptive material on a few of the major users' projects. We have selected the projects which follow with these criteria in mind: amount of usage, written material available, and varying types of usage of ACME. Dr. DeGrazia's work in Nuclear Medicine involves the use of a model, realtime data acquisition, and graphics terminals. The Immunology Project of Dr. Fries is an information retrieval project on a large data base. Dr. McConnell's project involves instrumentation that drives a plotter. ACME reads the X-Y coordinates via the 1800. Dr. Pauling's project involves realtime data collection of time series data from gas chromatographs, plotting of data and analysis. Dr. Petralli's work in the Infectious Disease Laboratory is an example of a production program currently used to ensure good quality control in the handling of laboratory samples. The Stroke Registry Project of Dr. John Wilson entails creation of a data base, manipulation of data, and report generation.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Name: DeGrazia, J. Project: RADIOREN

Department: Nuclear Medicine

Project Description: Renogram data are analyzed with a kinetic model of renal function to determine whether (1) quantitative estimates of renal function parameters could be obtained and (2) advantage accrues from employing additional probes in performing hippuran renograms.

Four-probe renograms were performed on patients suspected of having renal disease. The sitting hydrated patient was given an intravenous bolus of I-131 hippuran. Four balanced probes, equipped with thick-walled collimators, continuously monitored activity over each kidney, the heart and the bladder. Data was obtained for thirty minutes directly through an IBM 1800 or recorded by audio tape.

Among the parameters derived are:

1) Effective renal perfusion, as a fraction of cardiac output;
2) Fraction of effective renal perfusion to each kidney;
3) Excretion rate constant for each kidney (a measure of tubular function);
4) Urine transport time for each collecting system (a measure of obstruction, dehydration, etc.).

The clinical value of parameter estimation is being evaluated and a comparison is being made between the two-probe analysis and that using four probes. Thus this is testing for improvement when areas of interest are used to form the data base. This program will be a model for diagnostic studies of other organs with radioactive isotopes.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Name: Fries, J. Project: DATABANK

Department: Medicine - Immunology

Project Description: This project establishes a large databank of clinical information and explores multiple uses of such stored information. The databank currently includes 1,200 patient visits and approximately half a million individual items of data. A variety of search procedures operate on this body of data to give answers to clinical questions, provide administrative data, perform retrospective research procedures, coordinate and evaluate ongoing prospective clinical trials, and provide data for clinical correlations.

The project grew out of clinical problems in establishing significant clinical and laboratory correlations in immunologic diseases and assessing these correlations in regard to classification, pathogenesis, prognosis, and response to therapy. Diseases in this area are characterized by involvement of a large number of organ systems, a large variety of associated laboratory abnormalities, and a course long in duration and punctuated with periodic exacerbations and remissions. A massive amount of data is thus generated by each patient and meaningful correlations may be obscure to the clinician and inaccessible to the clinical researcher. The data cannot be well handled retrospectively under current systems nor can they be handled manually.

An orderly comprehensive method of recording patient data structured with respect to time has been developed and established. Information recorded in this manner has been stored in the databank. Using the databank as a central information processing vehicle, associated physicians in the community have become active in clinical research projects of the division and are obtaining significant clinical information relevant to management of their patients. In the early stages, therefore, a regional medical system of physicians interested in rheumatic disease is being established with an upgrading and a monitoring of the quality of care in the region. The system was developed for rheumatic disease but is easily applicable to any disease area or to general medicine itself. Other groups associating with the project are actively pursuing these ramifications. The availability of the databank has greatly enhanced the clinical program and has resulted in the establishment of clinical fellowships and additional student learning opportunities. The teaching value of available accessible clinical information cannot be overestimated and these applications are in daily use.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Name: McConnell, H. Project: ABSORB

Department: Chemistry

Project Description: ACME is being employed for analysis of experimental paramagnetic resonance spectra and calculation of theoretical spectra. These paramagnetic resonance spectra arise from the application of the "spin label" technique to problems involving biological macromolecules. Biological problems which are currently being studied include cooperative oxygen binding to the protein hemoglobin and the relation of molecular orientation and motion to function in biological membranes and membrane model systems.

The paramagnetic resonance spectra that are obtained in spin label studies are recorded as the first derivative of an absorption curve. The area under the absorption curve is proportional to the number of spin labels giving rise to the signal. Spin label spectra give information on changes in conformation or motion of a macromolecule. Frequently, these changes are detected as a small change in the paramagnetic resonance spectrum. Quantitative measurement of these changes requires normalization of spectra from a series of experiments. ACME will be used to compute the double integral of the experimental spectrum and then to regenerate a normalized spectrum. Subtraction and addition of spectra will also be used to analyze experimental data. In addition, a program for generation of theoretically calculated spectra will be employed.

Name: Pauling, L. Project: MENTLRES

Department: Chemistry

Project Description: This project involves research on the molecular basis of mental disease. Samples of urine and breath are taken before and after a synthetic diet, and analyzed by gas chromatography for abnormal patterns. Computerization is necessary for collection and rapid analysis of large volumes of data, and the project has recently hooked into the ACME system. A small project on mental retardation has been run and future plans include a large study of schizophrenia with all analysis done within ACME.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Name: Petralli, J. Project: MED_DATA

Department: Medicine - Infectious Diseases

Project Description: Antibiotic-sensitivity testing gives physicians important information about treatment of specific infections. The fact that the Food and Drug Administration recently decided to regulate the formulation of antibiotic-sensitivity disks reflects the increasing awareness of the critical nature of this testing procedure. To improve the quality of antibiotic-sensitivity data (high potency single disc method) and to guide the interpretation of results and antibiotic selection, a computer program has been developed. Clinical information and zone sizes are entered into the ACME computer each day. As the information is given to the computer, the quality-control program immediately detects and challenges unusual results and directs the laboratory technician to appropriate restudy of the organism in question. This system converts zone sizes to resistant, intermediate, or sensitive and prints final reports from its memory. Decreased potency of antibiotic disc is detected by comparison of periodically determined mean zone sizes. Limits of confidence of a single reading are established by review of zone sizes observed with a standard organism tested on different occasions. Knowledge of antibiotic sensitivities of organisms isolated from a specific site such as blood or urine will help to guide the selection of antibiotics before specific sensitivities are known. Such information is of value in selection of antibiotics in treating rarely encountered organisms with less well-known sensitivity patterns or in selection of alternate antibiotics when the first choice drug is hazardous. Yearly comparison of antibiotic sensitivity patterns obtained will give information about major trends and suggest appropriate changes in treatment of various infections.

Thus, a new weapon in the battle against disease has been developed -- a computer to keep tab on dangerous bacteria and to help select which antibiotic drugs should be used to treat infections. Through antiobiotic-sensitivity testing, the computer has completely eliminated errors in conversion from zone size to sensitivity, which otherwise occur once in every 12 reports.

In addition to improving the accuracy of laboratory results for the benefit of patients, the computer has proved valuable in checking the work of laboratory technicians and students undergoing training. With the initial goal accomplished, that of computer quality control of antibiotic-sensitivity testing, future plans call for the study of when and why organisms become resistant to antibiotics.

IV. PROJECT DESCRIPTIONS: CORE RESEARCH AND MAJOR USERS

Name: Wilson, J. Project: STROKE

Department: Regional Medical Program

Project Description: This project involves the development of a county wide registry on stroke patients for a period of one year. The goal is to develop a population base for study and analysis of descriptive parameters of stroke, correlations and relationships of parameters with resultant predictive output for improvement of treatment and care of patients.

To date, two programs have been written for input and storage of data on stroke patients in acute facilities. These can be used to update and correct data as well as in checking the accuracy of the data. Once the data has been input, two output programs can be run which give an evaluation of the patient's status upon admittance and discharge. For the period July 1, 1970 through February 28, 1971, data on approximately 300 patients has been stored in the computer file. Each month, data on 30-40 stroke patients is entered into this file via the teletype terminal located at the Dominican Santa Cruz Hospital. On the same terminal, evaluations of the patient's status on admission and discharge are obtained based on the computer data, and a printout of the data regarding the patient is placed in the patient's medical records. Preliminary statistical analysis (in the form of a monthly report) of the data obtained between July 1, 1970 and February 28, 1971 has also been completed.

Future plans include the continuation of data collection and processing. Enlargement of the stroke registry in the computer is anticipated to include data on long-term care of the stroke patient based on evaluations at three months, six months and a year after discharge from the acute facility. More sophisticated and definitive analysis of data will aid in improvement of care. Possible predictive relationships and correlations will be sought from the data.

V. USER CORE RESEARCH - FY1972

The user-related core research activities for the coming year will include the DENDRAL Program, Drug Interaction Program, Clinical Laboratory Data Collection and Analysis, Arrhythmia Detection, and other programs to be identified. Only the Arrhythmia Detection is a new project.

A. Current Core Research Projects

1. DENDRAL

ACME will be used to support DENDRAL over the next 12 to 18 months primarily by improving the LISP compiler and relating realtime services to DENDRAL needs. Some graphics support is contemplated for scanning search trees.

2. Drug Interaction Program

The Drug Interaction Program will continue but on new problems. The goal in FY1971 was to get prescription data into the system along with a patient census and to launch use of the system by the Pharmacy. For next year, Dr. Cohen is seeking a new grant for further work in relating drug interactions to more of the known factors about each patient (i.e., clinical lab data, admissions data).

3. Clinical Laboratory

Additional instruments in the laboratory will be connected to ACME for realtime data collection.

B. Proposed Core Research

1. Arrhythmia Detection

The Arrhythmia Detection System is planned as a joint effort between ACME and Dr. Don Harrison in the division of Cardiology. Dr. Harrison expects to use a small Hewlett-Packard computer as the control device for an arrhythmia detection system. The Hewlett-Packard computer would be connected to the ACME system for large file storage and data analysis. The detection system will be based largely on the work done at Washington University in Saint Louis by Dr. Jerry Cox and others, and will incorporate a number of new design concepts from a local group. This is viewed as the first step in a Cardiac Care Unit Monitoring Package.

V. USER CORE RESEARCH - FY1972

This project is included as ACME core research with the following conditions:

- This project is to be funded from ACME's income or otherwise as a cost above the basic budget of $800,000 in direct costs for FY1972.

- We are not attempting to compete with the study section review process. The basis for ACME's interest in this process is a future convergence of ACME's realtime goals with the overall Cardiac Care Unit Monitoring System.

At the present time the detection of arrhythmia depends upon two techniques:

- Analog devices that detect gross changes in heart rate.
- Visual EKG monitoring by trained nurses.

Neither of these techniques, alone or in concert, are wholly satisfactory. Devices that detect gross rate changes give an indication only after the patient has entered a life-threatening condition. By visual monitoring, trained nurses should be able to detect subtle arrhythmias which are often precursors to a life-threatening situation. However, it is obviously unrealistic to expect anything close to 100% effective visual monitoring. Limited attention span, fatigue, a number of tracings to watch simultaneously, plus the normal distractions of the CCU environment all vitiate the nurse's effectiveness.

What is needed is a technique that would be able to detect subtle arrhythmias and to provide constant monitoring.

This would be some sort of device that would be able to monitor EKG's on a beat-by-beat basis, detect the subtle arrhythmias that are precursors to life-threatening situations, and give an alarm that would allow a nurse to initiate proper treatment.

The heart of the arrhythmia monitoring system will be a high-performance mini-computer. The exact size of the computer, as well as the number of patients that can be monitored are yet to be determined. From past experience we expect to monitor 8 patients using a machine with an 8k memory. The execution speed of the machine is of critical importance since the number of patients monitored, and hence the cost-per-patient of the system, is primarily limited by this factor.

Input of EKG's to the system will be performed by a high-speed analog-to-digital converter. The analog-to-digital converter will interface to the normal central station cable connectors. Output of alarms will be augmented by additional alarm indicators to the normal central station alarm devices. This will allow for the normal operation of such devices as tape delays or graphics recorders.

2. Other Projects

Other core research applications will be identified in the course of the year. Potential candidates at this time include Dr. Eugene Dong's non-invasive arrhythmia detection system development, and some of Dr. De-Grazia's kidney function work in Nuclear Medicine. The principal investigator for ACME will issue new criteria for potential users to consider if they wish to become classified as ACME core research. Further discussions with NIH Biotechnology Resources Branch are needed on this subject.

3. Realtime Programs

We will attempt to expand the number of realtime users. These users have received a priviledged rate for ACME use because they have been pioneering a new area and are sharing the problem solving techniques developed with the community. As part of our move to become self-sufficient through fee for service, we expect to reduce the subsidy.

PART 3: UTILIZATION AND COST DATA

VI. BUDGET

A. Resource Expenditures

SUMMARY

		Total Resource Expenditures		
		Actual Previous Budget Period	Current Budget Period	Estimated Next Budget Period
1.	Personnel:			
	a. Salaries & Wages	201,673	237,973	247,735
	b. Fringe Benefits	24,710	32,942	37,384
	Subtotal	226,383	270,915	285,119
2.	Consultant Services	1,500	800	1,000
3.	Equipment:			
	a. Main Resource-Rented	367,394	375,254	365,825
	b. Main Resource-Purchased	27,453	39,251	61,136
	c. Supporting Equipment	10,876	10,120	8,382
	d. Equipment Maintenance	4,225	6,559	8,670
	Subtotal	409,948	431,184	444,013
4.	Supplies	12,939	13,500	16,250
5.	Travel	3,896	3,600	4,000
6.	Engineering Services	20,508	17,810	30,000
7.	Publication Costs	4,262	4,000	4,000
8.	Other			
	a. Computer Services (1)	12,177	9,660	7,000
	b. Other	7,915	7,900	8,618
	Subtotal	20,092	17,560	15,618
9.	Subtotal - Direct Costs	699,528	759,369	800,000 (3)
10.	Indirect Costs (2)	114,954	140,404	171,598
11.	Total Costs	814,482	899,773	971,598

(1) Includes IBM education courses

(2) Based on salary and wages in years 04 and 05; based on net ($800,000 - equipment rentals and purchases totalling $428,077) total direct costs in year 06 (will be reduced by netting revenue from service fees from direct costs)

(3) This budget level does not include the efforts we would like to fund using ACME's income. For example, see estimate for arrythmia detection work on page 52.

VI. BUDGET

EXPENDITURE DETAILS

Direct Costs Only

	August 1, 1970-July 31, 1971	August 1, 1971-July 31, 1972
1. Personnel		
Director's Office	46,597	48,645
Systems Programmers	78,379	76,213
Applications Programmers	41,749	47,315
Research Assistants	6,940	7,394
Operations	51,953	54,948
Secretarial & Administrative	12,355	13,220
Subtotal Salaries	237,973	247,735
Staff Benefits	32,942	37,384
TOTAL PERSONNEL	270,915	285,119
2. Consultant Services	800	1,000

VI. BUDGET

EXPENDITURE DETAILS

Direct Costs Only

			August 1, 1970-July 31, 1971		August 1, 1971-July 31, 1972
3. Equipment					
IBM Rentals					
IBM 360/50					
1052	Console Typewriter		635		635
1403	Printer 600 LPM		8,397		8,397
2050	Additional CPU (F)		97,348		97,348
2314 #1	Dir. Acess Storage		52,920		51,720 (2319)
2314 #2	Dir. Acess Storage		52,920		51,720 (2319)
2361	Core Storage		76,161		76,161
2401	Mag. Tape Unit		3,377		3,377
2403	Mag. Tape Unit Control		8,971		8,971
2540	Card Reader Punch		6,653		6,653
2701	Data Adapter Unit		10,332		10,332
2702	Transmission Control		16,834		16,834
2821	Control Unit		10,937		10,937
	Subtotal 360/50		345,485		343,085
Disk Packs (IBM 2316/3-M)		(16)	3,226	(25)	2,100
Terminals (2741)		(12)	12,167	(7)	7,436 *
IBM 1800 add. units					
1442			2,591		2,591
1826			7,691		7,691
1856			1,663		1,663
	Subtotal, 1800		11,945		11,945
Unit Record 029			1,192		1,259
	TOTAL, IBM RENTALS		374,015		365,825
Miscellaneous Rentals					
Hazeltine Displays (excluding interface)			1,239		---
	Subtotal, main resource rentals		375,254		365,825

*includes 1 month overlap of replacement of four IBM 2741's by purchased Beehive alphanumeric terminals

VI. BUDGET

EXPENDITURE DETAILS

Direct Costs Only

	August 1, 1970-July 31, 1971	August 1, 1971-July 31, 1972
Purchased Equipment		
IBM 1801 core	18,734	
Prentice Data Couplers - 2	626	
Textronix Scope Carts	333	
Prentice Modems	4,182	
Litton Printer (for Drug-Interaction)	4,053	
Litton Printer (for Drug-Interaction)	4,053	
Alpha-numeric Displays (Beehive) (D-1)	7,270	(4) 16,936
DEC Disk Drive	15,120	
Less portion of proceeds from sale of 270 x/y	(15,120)	
Electronic Testing Equipment		1,000
Two 1200 baud data sets/interfaces for portable graphics		3,200
Small computer equipment pool		40,000
	39,251	61,136
Data Set and Line Rentals	10,120	8,382
Maintenance (under outside contract)	6,559	8,670
Total Equipment	431,184	444,013
4. Consumable Supplies		
Office	3,500	4,000
Computer	8,500	10,250
Cables (Core Research Interface)	1,500	2,000
Total Consumable Supplies	13,500	16,250
5. Travel		
Jamtgaard--IBM Class, S.F., 7/14-21	37	
Wiederhold-ACME Seminar, U. of Minn., 7/29	67	
Jamtgaard--Wash. Univ., Computer Labs, 7/29-30	304	
Frey --SHARE, Montreal, 8/17-20	574	
Crouse --U. of Calif., Irvine, 9/18	70	
Jamtgaard--U. of Texas Med. Center, 11/17-19	379	
Wiederhold-AAAS Conf. & ASSA Conf., Chicago & Detroit, 12/26-28	382	
Frey --SHARE Conf., L.A., 3/8-12	240	
All Other Travel	1,547	
	3,600	4,000

VI. BUDGET

EXPENDITURE DETAILS

Direct Costs Only

		August 1, 1970-July 31, 1971	August 1, 1971-July 31, 1972
6.	Engineering Services	25,200	30,000
	Less portion of proceeds from sale of 270 x/y	(7,390)	
		17,810	30,000
7.	Publication Costs	4,000	4,000
8.	Computer Services		
	360/67	8,000	5,000
	IBM Education Courses	1,660	2,000
	Total Computer Services	9,660	7,000
9.	Other Expenditures		
	Books and Periodicals	400	500
	Postage and Freight	600	600
	Telephone	6,500	6,500
	Physical Plant	200	718
	Technical Services	200	300
	Total Other Expenditures	7,900	8,618
	GRAND TOTAL -- DIRECT COSTS	754,502	800,000

ARRYTHEMIA DETECTIONS *

Personnel	
Systems Programmer, one man-year	16,000
Systems Programmer, one-half man-year	6,500
Research Associate, three man-months	5,000
Subtotal Salaries	27,500
Staff Benefits	4,562
Total Personnel	32,062
Technician Engineering Services	10,000
Supplies	1,000
Total estimated costs of core project	43,062

* Example of a medical computation application ACME would like to fund from revenue from fees for service.

VI. BUDGET

B. Summary of Resource Funding

	BUDGET PERIODS		
	Actual Previous Budget Period	Current Budget Period	Estimated Next Budget Period
Source of Funds			
Computer Equipment - Service	$ 178,252	$ 160,000*	Approx. $ 250,000
Biotech. Resources Branch Support			
Amount of Current Award: Line (5) of Award Statement	712,689	675,747	713,342
Adjustment from prior periods: 1. Line (4) of current Award statement	0	76,459	17,883
2. ROE Adjustment	(76,459)	(17,883)	
Total BR Support	$ 636,230	$ 734,323	$ 731,225
TOTAL FUNDING	$ 814,482	$ 894,323	(Dependent on Income & Policy)

* Extrapolation from funds from service charges August, 1970 through April, 1971.

C. Resource Equipment List

RENTAL EQUIPMENT

360/50 Configuration

TYPE-SERIAL	DESCRIPTION	RENTAL START DATE	MONTHLY RATE		E/A%	EDUCATIONAL ALLOWANCE	TAX	NET RENTAL
1052-50618	Console Typewriter	12-13-66		63.00	20	12.60	2.52	52.92
1403-14708	Printer 600. LPM	"		833.00	20	166.60	33.32	699.72
2050-11047	Additional CPU (F)	"		1,600.00	25	400.00	60.00	1,260.00
2050-11047	CPU	"		10,040.00	35	3,514.00	326.30	6,852.30
2314-11149	DIR ACESS STGE	4-12-68		5,250.00	20	1,050.00	210.00	4,410.00
2314-12326	DIR ACESS STGE	1-6-69		5,250.00	20	1,050.00	210.00	4,410.00
2361-10102	Core Storage	7-1-68		10,990.00	45	4,945.50	302.23	6,346.73
2401-10877	MAG TAPE UNIT	12-13-66		335.00	20	67.00	13.40	281.40
2403-70738	MAG TAPE UNIT CONTROL	"		890.00	20	178.00	35.60	747.60
2540-12531	CARD READER PUNCH	"		660.00	20	132.00	26.40	554.40
2701-11144	DATA ADAPTER UNIT	12-13-66		1,025.00	20	205.00	41.00	861.00
2702-20185	TRANSMISSION CONTROL	12-13-66		1,670.00	20	334.00	66.80	1,402.80
2821-12464	CONTROL UNIT	"		1,085.00	20	217.00	43.40	911.40
	360/50 Configuration Total			30,691.00		12,271.70	1,370.97	28,790.27
	Supporting Equipment Rentals							
16 units 2316	DISK PACK (IBM) *	4-12-68	(@ 20.00)	320.00	20	60.00	12.00	272.00
8 units 2741	Communication Terminal	various	(@ 100.50)	804.00	20	160.80	32.16	675.36

* to be changed to 3-M

RENTAL EQUIPMENT (Cont.)

Supporting Equipment Rentals (Cont.)

TYPE-SERIAL	DESCRIPTION	RENTAL START DATE	MONTHLY RATE		E/A%	EDUCATIONAL ALLOWANCE	TAX	NET RENTAL
3 units 2741	Communication Terminal	various	(@ 105.50)	316.50	20	63.30	12.66	265.86
1 2741	Communication Terminal	8-1-70		113.50	20	22.70	4.54	95.34
1800 Rental Equipment								
1826	Data Adapter Unit	9-22-66		640.92	none	--	--	--
1442	Card Read Punch	"		215.92	none	--	--	--
1856	Analog Output Terminal	6-24-70		69.34	none	--	--	--
Other Rented Equipment								
Card Punch	IBM (Model 029/P4202)	9-21-70		104.87	--	--	--	--
5 Data Sets	Westinghouse Electric (Model 103A2)			193.50	--	--	--	--

PURCHASED EQUIPMENT

Period Covered -- 8/1/67-4/30/71

DESCRIPTION/IDENTIFICATION	MANUFACTURER	MODEL NO.	PURCHASE PRICE	SOURCE OF FUNDS
1800 System				Genetics I.R.L.
Process Controller	IBM	1801		
Printer Keyboard	"	1816		
Enclosure	"	1828		
Analog Input Terminal	"	1851	2,908.00	

VI. BUDGET

PURCHASED EQUIPMENT (Cont.)

DESCRIPTION/IDENTIFICATION	MANUFACTURER	MODEL NO.	PURCHASE PRICE	SOURCE OF FUNDS
Digital Display	ACME		(1)	SRR
Oscilloscope	Hewlett-Packard		1,500.00	Macy Grant
Pulse Generator	E. H. Research Labs	139B	1,275.00	Macy Grant
Conversion 1801	IBM	2B	18,753.00	
PDP-11 System	Digital Equip.	PDP-11	17,891.00	
Oscilloscope	Textronix	547	3,253.00	
Printer	Litton Industries	30	4,053.00	
Module/Packs	Prentice	800/LDA-1	2,972.00	
Oscillator/Generator	Wavetek	130	309.00	
Couplers (2)	Prentice	DC 22	939.00	
Module	Prentice	LDA 1	383.00	
Cabinet	Prentice		4,182.00	

(1) Fabricated and assembled by ACME staff.

D. Budget Justification

The budget does not reflect the shift in emphasis which is highlighted throughout this report, that ACME will give top priority in the coming year to designing and implementing a transitional system. After various preliminary studies have been completed, budget adjustments to accommodate the needs as then forseen will be requested. Another significant point is the disposition of income earned through fee-for-service charges. ACME is proposing that the income revert to the Stanford medical community to support extensions of ACME's core research efforts. This item will be the topic of further discussion with NIH.

Direct Costs

An increase in direct cost of slightly less than $40,000 is requested for the next fiscal year, bringing the total direct cost base to $800,000. The increase over the current year will be used to create a small machine equipment pool, provide slightly more engineering services, and cover normal cost escalation. No new positions are requested in the budget although a part of the numerical analyst position is shown in the NIH budget for the first time. ACME has used a faculty member on a half-time basis during the past year using University funds. The presence of high level help in mathematics and numerical analysis has been helpful to both ACME staff and users. The expense associated with this 25% of full time salary commitment is less than the terminal leave funds expended during the current year for David Cummins and Serge Girardi. The only other changes in the personnel budget are for merit increases.

Equipment

The equipment budget (lease and purchase) calls for a $13,000 net increase. The details supporting this estimate include two significant purchases. First, ACME intends to form a small machine equipment pool as described in Section III of this report. The $40,000 shown for this new activity will be supplemented in future years as the pool expands. The second major equipment acquisition involves four alphanumeric displays with upper and lower case. The cost estimate is based upon Beehive Model 3 units plus $800 per terminal for interface cards to the PDP-11, drivers, receivers, and cables. These units communicate with the PDP-11 at 4800 baud via an 8-bit serial interface. Two other equipment items are identified in the budget: engineering test equipment for the maintenance of existing equipment and two data sets which will permit data rates of 1200 baud between ACME and the 611 "add-on" displays over normal telephone lines. Lease of the 360/50 system will cost less in the next fiscal year due to replacements ordered for disk drives and packs. An order has been placed to replace two 2314's with two 2319's at a monthly savings of roughly $100 each. During May, 1971, all IBM disk packs were replaced by 3M packs at a rental cost savings of roughly 50%. The complete savings is not apparent as nine of the packs which are actually part of the basic system have been charged in the past to a University account; next year's grant account will be paying for all packs.

Finally, IBM rental costs will be decreased by five 2741 typewriter terminals four of which will be replaced by the alphanumeric displays. The fifth 2741 is being cancelled in order to keep the direct cost total within the $800,000 ceiling recommended by NIH Research Council.

One change made this year in the equipment configuration will have negligible effect on next year's budget, but it has materially affected service levels. The 270X and three 270Y's were purchased in conjunction with funds from the Genetics Department's Instrumentation Research Laboratory and the Chemistry Department in ACME's second year. This equipment was intended to serve as the medium rate interface between data gathering realtime users and the IBM 360/50 system but did not live up to ACME's expectations. This year IBM bought the unit from Stanford. NIH grant's share of the proceeds from this resale was $27,802. These proceeds are being used this year to procure:

RK-11, DEC Pack Disk Cartridge Drive Controller and DEC Pack Removable Disk Cartridge System	$ 15,120
Interface to replace 270X/Y's	5,120
Engineering services for interface between PDP-11 and IBM 360/50	2,270
Total	22,510

Each of these items filled a need which the 270X7Y would have done if it operated satisfactorily. Since the sstimated cost of these items exceeds the sale proceeds, funds for part of the engineering services have been supplied from the general budget line item for engineering services. This leaves $5,292 in equipment sale proceeds which will be carried forward to next fiscal year to fund replacements for other 270X/Y functions.

Supplies

The supplies budget includes some increases. Comsumption of printer paper has risen sharply in recent months due to announcement of new printing services for users. The budget for 360/67 services has been reduced from $8,000 to $5,000 in hopes that fewer core dumps and such servinces will be used. We have made no attempt to include /67 charges for mounting an interactive PL language.

VI. BUDGET

Arrhythmia Detection

The last item in the detailed budget presentation is a cost estimate for the first year of the Arrhythmia Detection Development Program. Note that these costs are considered incremental over the $800,000 direct cost base budget. This extension to the ACME core research activity appears to present an improvement to medical care which can be justified by community hospitals on a cost/performance basis. We hope that this work will be funded either through an increase in the base ACME budget of direct cost or through a new arrangement with respect to income from ACME users.

Stanford has adopted a new basis for calculating indirect costs to be effective September 1, 1971. Modified direct costs will be used for applying indirect costs. Since ACME charges a fee for services, there are questions of whether the full impact of the indirect costs should be levied on the RR-311 grant or be passed on to users. There will be no pyramiding of indirects. This budget assumes that users will be charged indirects on top of their ACME computer service charges. Therefore, the indirect rate of 46% of modified direct costs has been applied to ACME's estimated direct costs. This indirect figure of $171,085 will by reduced by 46% of the estimated income for FY1972. The conversion to this new method of applying indirect costs has raised numerous questions within the Stanford family. NIH will be notified prompthly of any changes to the plan outlined here.

E. Income Basis for Extension Request

ACME requests an extension of 15 months in the three year grant expiring July 31, 1972. The basis for this request is twofold. First, additional time is required to raise income; second, transition time is needed

Income in the current year for ACME services will be approximately $160.000 to $170,000. The value of services provided by ACME to it's user community is far greater. For example, excluding utilization by ACME staff, income in the month of March would have been an excess of $60,000 if all users had been charged 2-1/2¢ per pageminute. The 2-1/2¢ per pageminute rate incidentally is considered to be a full cost recovery rate and also a rate which would be competitive with other timesharing services. Thus, the problem is to encourage current unfunded users to obtain University or outside funding for their research and teaching work. Furthermore, the subsidized users of ACME who now pay roughly 25% of the value of the services received will need to obtain enough incremental funding from their sponsoring agencies to continue these services. An estimate of income is attached which assumes that users will be successful in obtaining funds to support continued use at higher rates (factor of 2 to 3 growth over present subsidized rates). These growth rates would still be less than estimated full cost recovery yet competitive rates.

VI. BUDGET

F. ACME Estimated Income Rate by End of FY1973

Category	Description	Present Rate(per pgmin.)	April '71 Act. Income	Approximate Growth of Service Rate	Approximate Loss From Increased Rate	Est. Net Income
	Funded Projects					
1	Real time, Medical School	1/2¢	$4356	3X	30%	$ 9,000
2	Research, Medical School	1¢	8624	2X	25%	13,000
3	Non Medical	2¢	498			500
8	Hospital Administration	1 1/4¢	2769	2X	55%	2,500
9	Stanford Campus	2 1/2¢	2421			2,500
						27,500/mo. x12
					Sub-total	$330,000/yr.
	Core Research Projects (currently unfunded)					
5	Real time, Core Research	1/2¢	320	3X		1,000
6	Medical Research, Core Research	1¢	4531	2X		9,000
						10,000/mo. x12
					Sub-total	$120,000/yr.

Currently Unfunded Projects

- Student computing programs
- Computing instruction for students
- Unsponsored research for faculty

} See note 1

- Pilot projects (old and new) and new users — Sub-total $50,000/yr.

TOTAL $500,000/yr.

Note 1: We have not identified a future source of funding for these users.

VI. BUDGET

Taking the availability of funds within the community into account, income from ACME users is more likely to be around $250,000 to $300,000 in FY1972 and less than $500,000 in FY1973. Although this level of income will not be adequate to support the present cost of offering ACME service, it is a significant level of computing support to be provided from the Stanford community. If the income rate in the summer of 1973 were to exceed $650,000, the Stanford Medial School could likely affort to maintain a stand alone facility offering services exclusive of system development very similar to those now provided.

If, on the otherhand, the total income from the medical community is less than 1/2 million dollars per year beyond July, 1973, mergers or joint ventures must be designed and implemented to be ready by that point in time. These will be explored over the next several months.

VII. UTILIZATION DATA

A. Interpreting ACME Utilization

The terms used to discuss ACME utilization involve charging units and categories of users.

1. Charging Units

The computer service units for which ACME charges are:

- pageminutes
- terminal access hours
- blocks of disk storage
- terminal service charge

A pageminute is defined as occupancy of 4k ~~10,000~~ bytes of core for 1 minute. A user's program which occupies 10 pages of core would result in a charge of 10 pageminutes per minute of terminal access time. Terminal access time is the total number of minutes that a user's terminal is connected to the system in a logged-on condition. A block of disk storage is a fixed length block of 2,000 bytes of 2314 disk storage. The terminal service charge covers monthly terminal rent plus other services offered by the ACME staff to it's user community. This service charge is handled by the University independent from the ACME Grant. At the present time ACME does not charge for related services such as card reading, printing, and use of graphics terminals.

2. User Categories

This table shows the Category identifier, rate, and definition of each user category at ACME. The rate charged per pageminute varies by user categories and some categories are subsidized 100% by the ACME Grant. An asterisk next to the category identifier (*4) designates those so subsidized. All other categories are paying. There is a distinction between realtime and non-realtime users. Realtime users use the 1800 processor or 2701 data adapter for data collection or process control functions in addition to the terminals. Category pairs 1 and 2, 5 and 6. 10 and 11, 12 and 13, and 14 and 15 differ from each other in only that one respect.

VII. UTILIZATION DATA

Category	Rate/Pageminute	Definition
1	1/2¢	Biomedical Research, Realtime.
2	1¢	Biomedical Research.
3	2¢	Non-Stanford Medical Clinics and Research Foundations.
*4	1¢	Medical Student education; includes graduate students and fellows.
*5	1/2¢	Core Research, Realtime: Projects designated by the principal investigator.
*6	1¢	Core Research.
*7	1¢	ACME Staff.
8	1-1/4¢	Medical School and Hospital Administration.
9	2-1/2¢	Non Medical: Stanford University.
*10	1/2¢	Pilot projects, Realtime.
*11	1¢	Pilot Research.
*12 and 13		Extended non funded: Extension of Categories 10 and 11.
14 and 15		Suspended pending individual Institute approval (as of March 31, 1971, this category was merged with categories 1 and 2 respectively).

VII. UTILIZATION DATA

B. Utilization Trends

The graph in Section VIIC. includes a six month moving average for pageminute utilization. This average has been hovering about 12 million pageminutes per month for the past year. In the month of April 1970, more than 2.5 million pageminutes were delivered. Taking into account the plans of various major users, we expect monthly utilization to average 2.5 to 2.8 million pageminutes per month for the next several months. This would represent approximately 20% growth over utilization figures for the past year. There is also additional utilization which this measure does not show: ACME has improved it's system efficiency and fewer pageminutes are required now to provide the same level of computing service as a year ago.

The six month moving average for terminal hours has increased from 3100 hours in April 1970, to more than 3700 hours in April 1971. Despite wide monthly fluctuation, it appears that terminal usage is growing at the rate of approximately 20% per year. In February 1970, ACME announced a rate reduction to it's users but at the same time, started to charge for terminal assess time. Each terminal connected to the ACME system ties up a 2702 transmission control port. Since there are only 31 such ports in the ACME system, a pricing mechanism was needed to ration the resource. Terminal hours have increased despite this new accounting method.

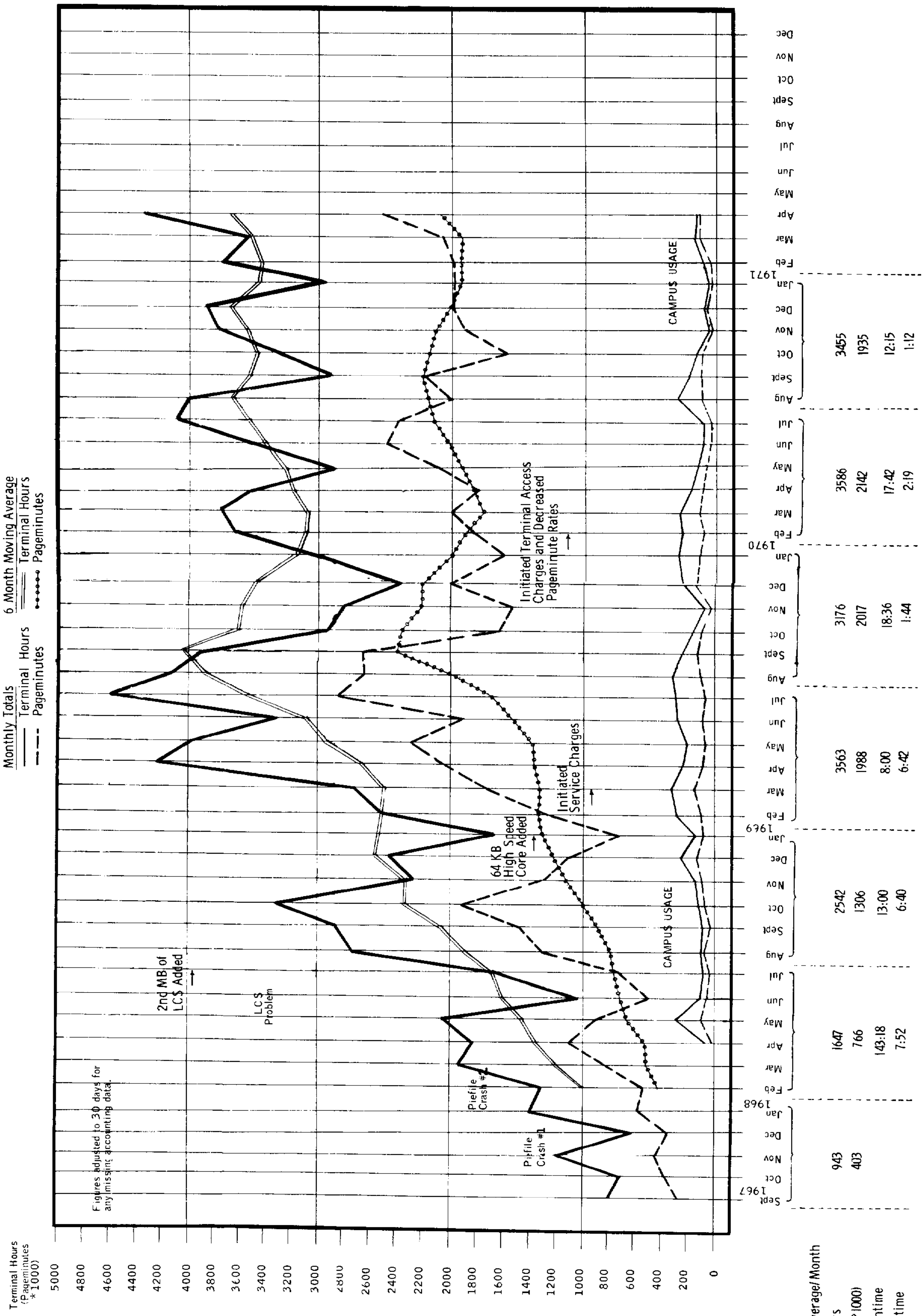
There is another change in utilization of ACME; one year ago one could commonly find 20 or more users logged-on during daytime hours with 30% to 40% of the users in execution. Today, when 20 or more users are logged-on, it is common to find 50% to 60% of them in execution. One might infer from this that users are doing less program development and more application work which is to be expected as the computing system matures.

Use of the system during evening hours (8:00 - 10:00 p.m.) has increased by about 50% during this past year. As daytime utilization of the system increased, some users found computer service far better during the evening. Summer utilization generally exceeds winter utilization. June, July, and August are historically the periods of heavy use.

Future computing requirements are not well defined. Last October and November, a survey which indicated a broad spectrum of requirements was conducted in the Stanford Medical Center. The results of the survey are presented in Part 3.

Monthly Usage at ACME

The system has had 365 pages (4,000 bytes each) available for users since the last increment of core was added in January 1969. As of November 1970 the network included 53 2741 terminals.



Six Months Average/Month	Sept 1967–Jan 1968	Feb–Jul 1968	Aug 1968–Jan 1969	Feb–Jul 1969	Aug 1969–Jan 1970	Feb–Jul 1970	Aug 1970–Jan 1971
Terminal Hours	943	1647	2542	3563	3176	3586	3455
Pageminutes (*1000)	403	766	1306	1988	2017	2142	1935
Hardware Downtime		143:18	13:00	8:00	18:36	17:42	12:15
Software Downtime		7:52	6:40	6:42	1:44	2:19	1:12

2. ACME Utilization By Department

March 1971

Department	# of Terminals	PAGEMINUTES students	PAGEMINUTES non-chargeable	PAGEMINUTES chargeable	BLOCKS students	BLOCKS non-chargeable	BLOCKS chargeable
Anesthesia	3	53,626		24,027	2627		4806
Biochemistry	2	15,270		2593	267		374
Bio Sciences	1			19,932			287
Cardiology	1	7483			937		1264
Cardiovasc Surgery	2		17,806	83,955	185	649	2469
Chemistry	2		69,793	267,377		3668	5199
Comm & Prev Med	1			17,233	348		2603
Dermatology	0					431	131
Genetics	7	25,228	98,618	143,797	1941	772	7658
Gyn/Ob	0			4864			114
Infectious Dis	1			35,218	153		1283
Lipid Research	1			16,806			479
Medicine	2	5050		50,139	232		2334
Med Micro	1			32,666	86		1122
Neurology	0		13,237		85	2332	
Pathology	2			58,360	114		569
Pediatrics	1	1356	9149	4312	2017	1628	439
Pharmacology	2		81,321	5464		4522	147
Psychiatry	2	1152	5610	21,699	2001	167	2802
Radiology	2	10,330		56,165	2189		2619
Spch & Hearing	0		25,656		52	1426	
Surgery	1			2021	327		449
Urology	1		50,615	2871		1579	40
Admissions Comm	0			7932			248
Regional Med Prog	1			16,377			786
Clinic Billing Office	1			137,599			8152
Private Clinics	0			14,241			477
Other	3			48,085			2621
TOTALS	40	119,495	371,805	1,052,034	13,561	17,174	49,472

3. ACME Facility Income
(April 16, 1970 - April 15, 1971)

A. Chargeable Categories	1970 May	June	July	August	Sept	Oct	Nov	Dec	1971 Jan	Feb	March	April
1 - Real-time, med school	$ 994	$1625	$1733	$2159	$1812	$1275	$2230	$2134	$2172	$2187	$3603	$4356
2 - Research, med school	3568	4429	8768	4203	4868	4411	4013	3807	4982	5472	4790	8624
3 - Non Medical	131	222	270	712	278	403	342	229	191	339	332	498
8 - Med School and Hospital Administration	2205	2635	2430	2369	2419	2713	3039	2628	1795	2410	2535	2769
9 - Stanford campus	2230	1721	1349	3459	1283	750	521	1328	934	1260	4209	2421
14 - Real-time, suspended	1627	1646	2593	1205	101	94	70	84	81	138	186	
15 - Research, suspended	3583	3706	2353	1985	2220	1727	1646	1685	763	433	452	—
MONTHLY TOTALS	$14,338	$15,984	$19,496	$16,092	$12,981	$11,373	$11,861	$11,895	$10,918	$12,239	$16,108	$18,668
											TOTAL FOR YEAR	$171,953
B. Income Reported and Later Credited*					$1901	$2233	$493	$811				
											TOTAL FOR YEAR	$5,438
C. Terminal Charges and Engineering Services Rebilled**	$8346	$8100	$7768	$6739	$8216	$9097	$8440	$8665	$8100	$9618	$7439	$8400***
											TOTAL FOR YEAR	$98,928

* This entry is shown to permit easy reconciliation to University financial statements.

**This income is not associated with the ACME grant. It is an offset to cost incurred by the University for terminal rental, engineering services, and other miscellaneous services provided to the ACME community.

***Estimated figure

PART 4: REFERENCE DATA

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Category 1

Name: Dong, E. Project: PATIENT

Department: Cardiovascular Surgery

Project Description: ACME has been used in collecting data from over 1300 patients. Data from cardiac surgery patients are entered and examined for survival, disease category electrocardiographic abnormalities. Patients may be monitored on a PDP-12, with data then being transferred to ACME for storage.

Name: Glick, D. Project: LASER

Department: Pathology

Project Description: The ACME Facility is needed to provide the computational requirements of the laser microprobe analytical system which we have designed, and are continuing to develop, for elemental analysis of microscopic biological samples down to the single cell and very small volumes of fluids. The applications of the system to biological and medical research and clinical medicine obviously have impressive potential. ACME is involved in data calculation for definition of sample size as well as content and concentration of elements. Statistical evaluations include calculation of F-ratio, T-test, U-test, population means and also linear regressions, graphical interpolations and curve fitting. A second system has been built so that one can be devoted to applications and the other to continued technological development. Eventually we expect to automate the system, which would further increase our dependence on ACME.

Name: Harrison, D. Project: CATHLAB

Department: Cardiology

Project Description: ACME is being used to analyze data for cardiac output using indicator dilution curve formularies, a variety of statistical analyses, text editing, and documented programs which are utilized on smaller computer systems. ACME is also being used to develop programs for the recognition of abnormal blood pressure and EKG complexes.

Future use of ACME will involve the development of a software-hardware system for clinical monitoring of critically ill patients in a coronary care unit. ACME is intended to be employed as a source to document programs developed on a small medical system in a clinical environment.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Reynolds, W. (P.I.: Lederberg, J.) Project: S007

Department: Genetics

Project Description: This project supports the basic development of automated mass spectrometer and other instrumentation systems.

The mass spectrometer has become of interest in the biochemistry field. In the case of DNA and related structures, the basic principles involved are common to at least the Genetics Department and to the Organic Chemistry Department. Hence the efforts of this project span over five mass spectrometers in three diverse locations on the Stanford campus. The technical development consists in the origination of instrumentation concepts and the realization, in both hardware and software, of complete operating systems.

These systems are intended to automate the mass spectrometers and to provide the following benefits to the biological user-researcher:

1) Saving of the researcher's time in instrument operation and data reduction;
2) Improvement in the quality of the data;
3) Improvement in the presentation of the data;
4) Fostering of computer files of pertinent data.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Category 2

Name: Assaykeen, T. Project: RENIN

Department: Urology

Project Description: Previous research reported shows that in dogs insulin-induced hypoglycemia significantly increases plasma renin levels. These studies are being continued in order to attempt to determine what the stimulus to renin secretion is under these conditions and how this stimulus is transmitted to the juxtaglomerular cells.

There is good evidence that the sympathetic nervous system can influence renin secretion but how this occurs is not known. This project is an attempt to establish whether catecholamines stimulate renin secretion through alpha or beta receptors, whether cyclic 3', 5' -AMP is involved and whether the effects of the catecholamines on renin secretion can be separated from the effects of these compounds on renal hemodynamics and function.

The results of such studies may lend support to existing theories regarding the control of renin secretion or may give new insight concerning the physiologic control of this important endocrine system.

Name: Bodmer, W. Project: POPGEN

Department: Genetics

Project Description: ACME is used for the analysis and interpretation of data on human white cell antigens. A secondary use is for the analysis and simulation of population genetic models. A series of programs have been developed to facilitate the storage of data with appropriate editing at the time of input and to facilitate a read interaction between the experimental worker and the computer. This allows one, at short notice, to do small scale 2 x 2 analyses for serum characterization, selection of appropriate individuals for absorbtion, and automatic typing according to complex patterns of serum reaction. These increased opportunities for interaction with the computer have been a great help in day-to-day work and in establishing new relationships amongst sera. Future plans include the development of programs for the systematic analysis of family data.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Forrest, W. (P.I.: Bellville, W.) Project: ANALGESI

Department: Anesthesia

Project Description: The 360/50 time-sharing real time system is used to research the management and statistical application of methods to the Cooperative Study. Problems of pilot studies, data validity, quality, cost of clinical trials and useful reduction of data for active sane management are constantly evaluated and updated. The plan is to develop an inexpensive system of quality and quantity control of large masses of clinical data from several sources so that diarrhea and "gigo" are diagnosed properly and treated prophylactically rather than symtomatically.

Name: Friedland, G. Project: SLING_FI

Department: Radiology

Project Description: The purpose of this study was to determine the action of the gastric sling fibers. Radiopaque tantalum wire was inserted into the distal esophagus and gastric sling fibers in eleven cats. Subsequently, simultaneous biplane radiographs were obtained of the esophagus and stomach in the unanesthetized cats following installation of barium into the upper esophagus. From these radiographs, the three dimensional movement of the markers was reconstructed using computer analysis. In two cats, two markers were placed on the anterior wall of the stomach close to the sling fibers in the direction of the long axis of the stomach, determining the relationship between movement of the gastric wall and the sling fibers. All cats were autopsied immediately following the radiographic examination to determine the position of the markers.

The sling fibers lengthened with distal esophageal opening in eight cats with correctly placed markers. In five of the eight cats, the distal esophagus closed within the time of the examination and the sling fibers shortened simultaneously. There was no relationship between movement of the anterior wall of the stomach and the sling fibers. This study demonstrated for the first time that the gastric sling fibers act in concert with the distal esophagus.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Herzenberg, L. Project: LAB

Department: Genetics

Project Description: Studies in immunology, genetics, and maternal fetal immunologic relationships in the mouse require the collation of many experimental observations on a given serum sample or individual. Since such data is accumulated over long periods of time, frequent interim reviews must be made to determine new directions, etc. Currently, most data collation in the laboratory is done by hand incompletely, inadequately and infrequently, thus hampering the process of the research. To overcome these difficulties, the process of changing data storage procedures to utilize the ACME capabilities has begun. For example, all breeding records for the inbred nucleus of our mouse colony are stored in ACME. Approximately once a month ACME is called upon to draw updated pedigree charges, so that breeding decisions may be made.

Programs have been written to collate multiple immunoglobulin level determinations done on individual serum samples, returning histories of immunoglobulin level changes with time in treated animals. ACME is being used to store data and direct antiserum production in the laboratory.

In addition to the data storage aspects of ACME, the computer is used in this laboratory for a number of routine calculations on data sets, e.g., per cent antigen precipitated, geometric means of plaque events, etc.

Name: Lamb, E. Project: EMPIRE

Department: Gynecology and Obstetrics

Project Description: ACME is being used for the following studies:

1) Calculation of relative potency and confidence limits of total gonadotropin activity of human urine extracts. These calculations have been used in a research project correlating the results of the total gonadotropin bioassay and an immunologic assay for LH using hemagglutination inhibition.
2) Calculation of results of chemical determinations of estriol in urine from women treated with gonadotropins for ovulation induction (research) and from pregnant women (service laboratory).
3) Calculation of conception rates using a modified life table method for estimating the prognosis for infertile couples.
4) Calculation of correlation between various parameters measured in the semen analysis with subsequent conception rates and with the result of a test for sperm agglutinins.
5) Tabulation of evaluations of student performance submitted by a large number of attending clinical faculty members.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Lederberg, J. Project: GENLIB1

Department: Genetics

Project Description: This project contains the statistical and miscellaneous programs used by the Genetics Department.

Statistical programs: General statistical analysis for the calculations of sum, mean, standard deviation, the analysis of variance, chisquare and probability of chisquare distribution, correlation and regression analysis, the normal distribution with the same mean and standard deviation for fitting a curve.

Plotting programs: Plot bar graph in 100 positions, plot of percentage distribution, plot by function scaled to the range of 0 to 100, plot of multivalued function allows the choice and supersition of several characters. Flag is inserted on the chart when underflow or overflow occurred.

Sorting programs: Sorting a vector in ascending order, sort array and alphabetical informations.

Name: Luetscher, J. Project: Blood_Pr

Department: Medicine - Metabolic Research

Project Description: This research project deals with the secretion and metabolism of adrenal hormones. Various steroid hormones, catecholamines, and trophic hormones are measured under different conditions of sodium loading or sodium depletion. The project attempts to define and relate groups of measurements which assist in the identification of curable forms of hypertension.

The ACME system is used in this project in several ways:

1) To assist in the calculation of laboratory data;
2) To interpret the data: (a) Simulation of complex systems, (b) Statistical analysis, (c) Analysis of clinical information.
3) To store information at various stages of a sequential process, and for collection and analysis of the large amount of clinical and laboratory data which accumulates during a long investigation;
4) To aid in research training of fellows and staff, first in principles and techniques of computer use, and subsequently in practical applications.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Luzzati, L. Project: GRAGSON

Department: Pediatrics

Project Description: Programs previously utilized for statistical analysis of chromosome measurements in a family with chromosomal abnormalities are now being used for an ongoing study of the morphology of the late replicating X chromosome. Programs are also used for another ongoing study of synchronization of human lymphocytes in culture.

The use of the ACME computer for the study of children with birth defects continues. In addition, a program is now available for the storage of anthropometric data on all patients with congenital defects. A study of anthropometric measurements and dermatoglyphic patterns of sixty children with cleft lip and/or palate, utilizing the data stored in the computer and computer-assisted statistical analysis, has been completed. By using computer information, we have been able to define certain characteristics of body configuration in children with clefts. Further similar studies in other syndromes are now in progress.

Name: Melges, F. Project: TEMPO

Department: Psychiatry

Project Description: This is a study to relate changes in temporal experience to changes in psychopathological symptoms such as depersonalization and delusions. The plan is to discover how aberrations in temporal sequencing and distinquishing memories from perceptions and expectations relate to the emergence of definable psychopathological processes. The overall notion for a number of sub-projects is: confusing past, present, and future underlies the central symptoms of psychosis.

Sub-projects involve specific attention to drug-induced psychoses and certain symptoms of psychoses, especially depersonalization, changes in body image, paranoid delusions, and feelings of influence or alien control. Previous work has demonstrated that this approach is highly useful for understanding psychotic processes.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Nall, L. (P.I.: Farber, E.) Project: PSORIASI

Department: Dermatology

Project Description: Psoriasis is a chronic, scaling skin disease of unknown etiology, which affects approximately 4% of the general population. It is a lifetime disorder which does not take life, but indeed destroys it for all age groups.

This project involves an investigation of the epidemiology of the disease. A questionnaire survey has been conducted from 1959 to date. Presently, work is being done on Series II, III, and IV of the questionnaire survey. Follow-up studies on the familial incidence of psoriasis and the relationship of psoriasis to other diseases are being done (i.e., arthritis, diabetes, throat infection). The findings from Series are now being handled by ACME's 360/50 computer.

Name: Reaven, G. Project: DISPLAY

Department: Medicine - Metabolism

Project Description: ACME is used for 1) Derivation of a three compartment model describing disappearance of plasma insulin, 2) Evaluation of the dog as an experimental model for study of insulin distribution in man, and 3) Digital on-line computer display to investigate the structure of metabolic systems. Models of glucose, insulin, and triglyceride kinetics as related to diabetes mellitus and atherosclerosis are being developed. Clinical data obtained from tracer studies are analyzed by the ACME computer through five states of development. The project DISPLAY includes the third and fourth stage. The third stage automatically obtains the parameters for a linear sum of constant coefficients of a system of linear differential equations. The results are used for the fourth stage. In this phase, the parameters are used for calculation of a theoretical curve which is displayed on a CRT. It is then compared with data which also appears on the CRT. The results of these two stages allow the changing of the parameters until a satisfactory visual fit is obtained. Similar analysis with respect to triglyceride metabolism and extension of the insulin work are now being performed. Stage four is being extended and stage five developed for analysis of non-linear metabolic models.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Stark, G. Project: CHAOS

Department: Biochemistry

Project Description: ACME serves two primary functions. First, it is used to analyze data generated from steady state kinetic experiments on enzymes, primarily aspartate transcarbamylase from Eschenchia coli. Second, it is used to process chromatograms generated by an amino acid analyzer. It is also used for various research and educational tasks by graduate students and medical students, such as analyzing the sedimentation velocity of proteins in the ultracentrifuge. Many of the kinetic experiments referred to above could not be done without the services of ACME, since they involve trial and error fitting of several parameters to complex functions. The routine processing of chromatograms on ACME introduces accuracy and dependability not otherwise available.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Category 4

Name: Enzmann, D. (P.I.: Zboralske, F.) Project: SWALLOW

Department: Medical Student

Project Description: The ACME computer is being used to assist in the study of both normal and abnormal motions of the humna esophagus during normal and induced swallowing. A series of simultaneous pressure readings in various locations in the esophagus are taken by the use of water filled manometers connected to electrical pressure transducers. The electrical voltages representing the pressure data are sampled and converted to digital values 5 times a second, for each of the pressure measurement sources, using the IBM 1800 computer attached to the ACME computer. The data from a swallow is then analyzed as it is obtained and immediate information is provided back to the experimenter, via the terminal, of the properties of the last swallow. Various summary tables are kept during an experimental run regarding the properties of all the swallows obtained, and are available for a final summary of the experimental data. Initially all the data obtained during an experimental run will be saved on data files to allow different methods of analysis of the data to be explored.

Name: Harris, R. (P.I.: Melges, F.) Project: PNP

Department: Medical Student

Project Description: This is a project which attempts to demonstrate correlations between the emotions experienced by subjects and their own appraisals of certain aspects of their environments. The concept is that emotions arise when events in the individual's situation come into certain specified relations with his goals.

The study has two parts. The first involves the collection of normative data from normal subjects with respect to six emotions; namely, anger, anxiety, depression, joy, love, and calm. Subjects will be instructed to recall experiences that typify their conception of these states and to describe them on inventories. This data is then used to construct normative profiles of each emotional state and to calculate correlations between different categories of items on the inventories. The second part of the study will employ a number of expectant fathers, who will be tested in the waiting room prior to delivery and again after the birth. This data will be used to determine whether previous normative data is useful in the identification of actual emotional states and to confirm the correlations found in the earlier part of the study.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Levine, R. (P.I.: Kretchmer, N.) Project: CPS

Department: Medical Student

Project Description: The purpose of this project is to characterize the control of de novo mammalian pyrimidine biosynthesis. The first two enzymes in the pathway, carbamoyl phosphate synthetase and aspartate transcarbamylase are of special concern. This first enzyme is distinct from an isozyme which provides carbamoyl phosphate for the urea cycle. Consequently the pyrimidine-specific enzyme appears earlier in gestation than that which is urea-specific.

ACME has been and continues to be utilized to evaluate and process data obtained during enzyme assays. However this is a relatively routin application. Programs have been devised to study the very complicated kinetics of the carbamoyl phosphate synthetase. Physical interpretations have been drawn from ACME-derived functions and the control mechanism of the enzyme has been greatly clarified. It is hoped that a TV screen will become available so that our kinetic analysis programs can have a visual interaction with the investigator.

Name: Odell, R. (P.I.: Krahl, M.) Project: CIS

Department: Medical Student

Project Description: The field of investigation is neuroendocrine biological control. Research is being done on the interaction of hormonal and neural events which could act as signals in transient and steady-state operation of physiological systems. The data used is based on experiments with dogs. An attempt is being made to understand biological communication systems and their signals in order to unravel physiological basis of behavior.

Name: Rosenfeld, R. (P.I.: Miller, W.) Project: CCUPSYCA

Department: Medical Student

Project Description: This is a research project on the psychophysiological adaptation of male patients to the Coronary Care Unit. The goals of the research are to try to establish some relationships between psychological variables and physiological variables, particularly as these latter affect the morbidity and mortality of patients with acute myocardial infarctions. The patients on the Coronary Care Unit are under constant daily observation and have a large number of physiological functions monitored. The study will provide a huge amount of data daily on each patient. The ACME computer will be used to store this data and make a number of statistical manipulations of the data.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Sachs, D. (P.I.: Lederberg, J.) Project: POPCIT

Department: Medical Student

Project Description: ACME is being used as a text editing system. Research is being done on population growth rates in various nations, and the resulting data is then correlated with natural resource use in those nations. The purpose is to understand medicine's role in alleviating problems posed by environmental deterioration. ACME's contribution to the project is that of storing text files on the data that has been collected.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Category 11

Name: Belt, D. Project: HSA

Department: Speech and Hearing

Project Description: This project constitutes a program in large scale hearing and vision screening testing. A professionally staffed mobile test laboratory has been collecting the results of hearing and vision tests performed on elementary school children. Data, which has been taken from four counties in the Bay Area, is being stored on mark-sense or punch cards for about twenty-thousand children and adults. Subsequently, the sample will be enlared to about sixty-thousand in order to provide a broad base for the analysis of the data.

The need for survey data on the incidence of hearing and vision loss is admitted with Public Health surveys dating back to 1957. It is because of this need that ACME has been employed in processing the results of these hearing and vision tests.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Bunnenberg, E. Project: CHEM

Department: Chemistry

Project Description: The main goal of this project is to achieve an effective interactive computer-assisted operation of a highly specialized type of spectrophotometer -- a magnetic circular dichrometer. The utilization of organic chemical and especially biochemical applications of magnetic circular dichroism will allow the following:

1) An increase in the operational sensitivity of the instrument through the application of digital averaging and smoothing techniques. This is especially important for this instrument because of its inherent single-beam operation;
2) The measurement of compounds having relatively strong signals much more rapidly;
3) The extraction of quantitatively meaningful spectroscopic parameters from the magnetic circular dichroism spectra. This is of crucial importance for much of the work and requires the implementation of generalized curve deconvolution and fitting programs.

To date, the first goal (1) has been accomplished. The instrument was used to analyze lunar soil extracts for metalloporphyrins. The second goal has been partially realized. In particular, a provisional conclusion was reached: (a) Computer operation greatly decreased the time required to scan through the MD spectrum of a routine sample and (b) computer operation on a routine basis is in fact economical. This second goal, it is anticipated, will be quite useful in increasing the efficiency of measuring MCD spectra and in permitting the application of various mathematical operations to the stored spectra. This should increase the utility of MCD spectrometry to a variety of biochemical problems,

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Cavalli, L. Project: PAVIA

Department: Genetics

Project Description: The purpose of this project is the simulation of populations. This simulation will be used for making predictions about evolutionary processes. Very often these processes are too complicated for standard analytical procedures; on the other hand, these simulations may indicate ways of recognizing the unimportant variables, and perhaps also indicate ways of simplifying the analytical treatment of populations. At the moment the problem of the relationship between the intensity of selection on a phenotypic character and the effect on the genes that contribute to it is under study.

Programs are also being developed for the statistical analysis for such processes and of a variety of genetic, epidemiological and other types of problems which often require the fitting of complex functions for which we must use the computer. These programs are generally sufficiently different from standard programs to warrant developing.

Name: Costell, R. (P.I.: Wittner, W.) Project: AHSO

Department: Psychiatry

Project Description: Ninety-five randomly selected, incarcerated sex offenders completed a questionnaire containing relevant demographic data, history of sexual activity, etc. The computer is used for tabulation, analysis and statistical testing of factors of significance in the sexual histories and activities of this population. Results may yield new information relevant to the pathogenesis of these deviations, and establish the validity of this method of data collection and analysis.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Eddy, D. (P.I.: Shumway, N.) Project: NIFTY

Department: Cardiovascular Surgery

Project Description: The purpose of this project is to develop an optimization technique for control of infectious diseases. Currently the individuals faced with controlling an epidemic have at their disposal a wide range of control measures. These vary from acute treatment of active cases, through public health programs, to immunization programs. A decision must be made as to how much of each mode of control should be applied to minimize morbidity and mortality while not exceeding available resources. Furthermore, the optimal mixture of preventive and curative programs is dynamic and varies as the disease progresses through a population. The multitude of control measures available, the interrelationships between the control variables and the behavior of the disease, and the constraints of limited resources and time present a problem far too complex for the individual mind.

This project will use a mathematical programming technique to find the optimal mixture of control methods to minimize morbidity and mortality while concurrently minimizing the demand for monetary and manpower resources. To demonstrate the technique, the disease Cholera has been chosen as an example. To date, two steps have been accomplished. A mathematical model of the disease has been constructed, and an algorithm which will find the proper weightings of the various control measures has been developed. The third step, which is the purpose of this project, is to implement the program on the ACME computer.

Name: Goldstein, A. Project: OFFSTUFF

Department: Pharmacology

Project Description: ACME is being used for periodic data summation, statistical tests, and tabular output of results of research in methadone maintenance programs in Santa Clara County. The purpose of this research is to determine the importance of the use of methadone in treating heroin addicts.

Name: Leiderman, P. Project: KENYA

Department: Psychiatry

Project Description: This project involves the analysis of data collected in a village in Kenya on physical, psychological, and social growth of infants during their first year of life. T-tests, Anova, Cluster analysis, Regression analysis, curve fitting are all being used. The importance of the work lies in changing family life in the underdeveloped world, nutrition, and factors influencing social relationships.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Category 12

Name: Constantinou, C. (P.I.: Govan, D.) Project: UROL

Department: Urology

Project Description: Studies are being done to improve the clinical appraisal, follow-up and management of patients with neurogenic bladder dysfunction secondary to spinal cord injury or disease. In particular, we are trying to determine the feasibility of utilizing computer-based techniques of information data storage, processing and retrieval in this patient population.

ACME is being used for real-time data acquisition and feedback, and for analysis. Analog data collected from anesthetized animals in surgery is transmitted via the interface box to the 1800 and 2741 output received in the operating room during the experiment.

There are six input channels used simultaneously for action potentials from ureteral smooth muscle, peristaltic pressure waves, urine flow rate, EKG and blood pressure. The analog output is used for driving the XY plotter and providing a reference for servomechanical pump. During experiments, data files are written from the analog inputs for long-term storage and also for short term (up to two weeks) before data reduction.

ACME is also used for statistical analysis of the experimental results utilizing repression, correlation, and convolution subroutines available in the system library. The digital TV and particularly the storage oscilloscope on periodic loan from ACME is used for the rapid display and examination of results.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Gersch, W. (P.I.: Tharp, B.) Project: SYNTHESI

Department: Neurology

Project Description: The application of time series methods to problems in neurophysiology and medicine is being studied. Specifically, research is being done in the following areas:

1) Development and application of new multidimensional autoregressive representation methods of spectral analysis to EEG analysis;
2) Development and application of a time series analysis technique to locate anatomical site of epileptic focus from human EEG data taken from scalp electrodes and implanted bipolar depth electrodes during generalized seizure activity;
3) Research on modeling feedback paths in the cat's visual system. Experimental data taken in the laboratory of Dr. K.L. Chow;
4) A critical computer analysis of a long standing model of vagus control of heart rate;
5) Development of a novel Markov chain-symbol pattern recognition procedure applied to recognition of cardiac arrhythmias using R-R interval data.

The evaluation of the electroencephalographic activity during seizures in three patients has been completed and is being compiled for publication. The major emphasis of this rather unique analysis method depends entirely on the facility available at ACME since there was no outside funding support.

Name: Glaze, H. (P.I.: Shumway, N.) Project: MODEL

Department: Cardiovascular Surgery

Project Description: ACME real-time experiments have been devised to characterize a subset of the time-varying, non-linear, and memory properties of the mammalian vagal-cardiac rate control system. Heart rate data from 20 anesthetized vagotomized dogs have been acquired on-line and programs have been written for quantitation of this data. A mathematical model has subsequently been developed and standard curve fitting techniques used for quantitation of this data. The project was used to complete development of the mathematical model and to obtain hard-copy plots of the results.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Name: Thathachari, Y. (P.I.: Blois, M.)   Project: DOPA

Department: Dermatology

Project Description: This is a study of the structure of melanins. Melanin is a polymeric pigment widely distributed throughout the plant and animal kingdoms. It has unusual physical and chemical properties. Using ACME as a real-time terminal, models of the molecular structure of melanins were generated starting with the known shape of the subunits and using various criteria for the linking of adjacent units. By watching the output periodically, the flow of the computation could be directed at will. For these generated models, various measurable physical data were computed and compared with the experimentally derived values. Programs were especially written for these calculations and were found to be very promising and fruitful.

Radioactive tracer techniques for the detection and therapy of melanomas are being studied. An attempt is being made to improve on the conventional scanning techniques, making more efficient use of observations with a real-time feed back between the collection of data and their processing. Simulated experiments using ACME are under way to make a choice between alternate techniques. When the choice is made, the project will commission the equipment and the interfacing with ACME.

VIII. REPRESENTATIVE SAMPLE OF USER PROJECT DESCRIPTIONS

Category 13

Name: Cann, H. Project: GUAT

Department: Pediatrics

Project Description: This project is an investigation of factors which affect frequencies of genes controlling various human heritable characters. The extent to which selection, genetic drift, and migration affect frequencies of certain human genes is being assessed and specific selective factors are being sought. Environmental, cultural, and historical conditions favorable for this type of study have been found in settlements of Mayan Indian descendents in the Lake Atitlan Basin of southwest Guatemala. The local microgeography and mating patterns appear to enforce a high degree of genetic isolation for each of a number of Indian towns and villages ringing Lake Atitlan. These high mortality populations provide the opportunity to study selection on human genetic polymorphisms. Studies of gene frequencies, segregation analysis of polymorphisms and demographic characterization of these sub-populations are being undertaken.

This project will also contribute information on the genetic taxonomy of the American Indian. Families of large size, characteristic of the study population, will afford excellent opportunities for medical genetic investigation of inherited diseases encountered in our field activities and for studies of genetic linkage.

Over 2500 Indians in seven communities on the shores of Lake Atitlan are being studied for heritable blood characteristics, fertility, mortality, and other demographic indicators and socioeconomic variables.

Grant No. RR00311-05
Section IX

IX. SUMMARY OF COMPUTER RESOURCE USAGE
CORE RESEARCH PROJECTS
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
ACME Staff -- Category 7 (FREE)						7		at .1 cent per pageminute	at .10 cents per block
Acme, P.L.	ACME	ACME classes.	*RR00311	NIH		7	0.190	0.267	0.190
Bassett, R.	ACME	User Consultation.	*RR00311	NIH		7	125.197	308.320	5.555
Beebe, R.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Berman, J.	ACME	System development and testing.	*RR00311	NIH		7	22.952	54.463	0.480
Berman, J.	ACME	System development and testing.	*RR00311	NIH		7	58.847	223.462	4.392
Berns, R.	ACME	System development and testing.	*RR00311	NIH		7	45.327	566.828	5.056
Berns, R.	ACME	System development and testing.	*RR00311	NIH		7	7.085	75.096	2.625
Brotz, D.	ACME	System programming.	*RR00311	NIH		7	3.802	6.195	0.113
Carr, D.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
C.E., IBM	ACME	Terminal testing and diagnosis.	*RR00311	NIH		7	23.517	39.971	0.665
Class, C.	ACME	Operations management. System testing and demonstration.	*RR00311	NIH		7	633.822	1712.839	14.533
Copeland, A.	Computation Center	System development and testing.	*RR00311	NIH		7	0.002	0.004	0.004
Cower, R.	ACME	Daily operations.	*RR00311	NIH		7	57.080	115.675	2.875
Crouse, L.	ACME	Development of real-time medical procedures.	*RR00311	NIH		7	60.370	340.998	50.292
Cummins, D.	ACME	Communication systems development.	*RR00311	NIH		7	15.805	65.557	0.546
Emerson, D.	ACME	File system development.	*RR00311	NIH		7	1.222	1.690	0.069
Feigenbaum, E.	Computation Center	System demonstrations.	*RR00311	NIH		7	0.0	0.0	0.024
Feigenbaum, E.	Computation Center	System demonstrations.	*RR00311	NIH		7	0.0	0.002	0.142
Frey, R.	ACME	File system testing; consulting programs.	*RR00311	NIH		7	19.792	52.128	7.890
George, D.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Girardi, S.	ACME	File testing.	*RR00311	NIH		7	18.630	27.268	4.205
Gold, D.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Granieri, C.	ACME	System development and testing.	*RR00311	NIH		7	0.313	1.194	0.252
Granieri, C.	ACME	System development and testing.	*RR00311	NIH		7	17.552	31.537	0.948
Graph, I.	ACME	System development and testing.	*RR00311	NIH		7	0.822	4.289	0.373
Hale, R.	ACME	System development and testing.	*RR00311	NIH		7	30.615	103.493	3.926
Hundley, L.	ACME	Real-time data acquisition.	*RR00311	NIH		7	64.580	179.036	8.871
Jamtgaard, R.	ACME	ACME director.	*RR00311	NIH		7	24.667	45.274	1.723
Job, M.Y.	ACME	Task management.	*RR00311	NIH		7	0.385	1.003	0.031

* Grant supporting more than one user.

SUMMARY OF COMPUTER RESOURCE USAGE
CORE RESEARCH PROJECTS
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ACME Staff -- Category 7 (FREE)								at .1 cent per pageminute	at .10 cents per block
Kelley, F.	ACME	Daily operations.	*RR00311	NIH		7	62.563	184.885	0.316
Lederberg, J.	Genetics	Text editing.	*RR00311	NIH		7	7.770	25.026	9.891
Lederberg, J.	Genetics	Program development.	*RR00311	NIH		7	129.320	480.819	56.642
Lederberg, J.	Genetics	System tests.	*RR00311	NIH		7	13.262	26.930	0.900
Lew, Y.	ACME	System development and testing.	*RR00311	NIH		7	7.832	15.065	0.553
Martin, C.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Matous, J.	ACME	Daily operations.	*RR00311	NIH		7	0.512	1.348	0.319
Miller, S.	ACME	System development and testing; user consultation.	*RR00311	NIH		7	29.502	65.559	4.153
Miller, S.	ACME	System development and testing.	*RR00311	NIH		7	0.160	0.376	0.430
Miller, C.	ACME	Text editing.	*RR00311	NIH		7	0.345	0.552	0.041
Miller, C.	ACME	Text editing.	*RR00311	NIH		7	2.420	4.418	0.814
Miller, J.	ACME	Assembler development.	*RR00311	NIH		7	0.012	0.016	0.024
Miller, J.	ACME	File development.	*RR00311	NIH		7	0.067	0.136	0.240
Montgomery, R.	Computation Center	Text editing.	*RR00311	NIH		7	0.0	0.0	0.024
Moore, J.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Osborne, D.	ACME	System tests.	*RR00311	NIH		7	18.517	37.123	1.589
Osterby, O.	ACME	System development and testing.	*RR00311	NIH		7	2.067	4.037	0.475
Pearson, J.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Plasch, G.	ACME	Text editing.	*RR00311	NIH		7	2.350	4.624	3.798
Public, J.Q.	ACME	Development and storage of PUBLIC files.	*RR00311	NIH		7	9.785	24.288	7.795
Reynolds, W.	Genetics	System development and testing.	*RR00311	NIH		7	32.660	260.318	1.376
Richardson, R.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Rieman, J.	ACME	Daily operations.	*RR00311	NIH		7	5.740	9.268	0.312
Saal, A.	ACME	Program development.	*RR00311	NIH		7	2.535	3.760	0.053
Salisbury, A.	ACME	File system development.	*RR00311	NIH		7	0.0	0.0	0.006
Sanders, G.	ACME	User consultation.	*RR00311	NIH		7	11.887	35.745	0.853
Sanders, W.	ACME	Hardware and software development.	*RR00311	NIH		7	0.595	1.391	2.780
Sandoval, C.	ACME	Daily operations.	*RR00311	NIH		7	63.632	148.109	3.001
Scharf, G.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002

* Grant supporting more than one user.

SUMMARY OF COMPUTER RESOURCE USAGE
CORE RESEARCH PROJECTS
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ACME Staff -- Category 7 (FREE)								at .1 cent per pageminute	at .10 cents per block
Schlumberger, A.	ACME	Program development.	*RR00311	NIH		7	0.130	0.179	0.009
Smith, P.	ACME	System tests by IBM system engineer.	*RR00311	NIH		7	0.105	0.140	0.518
Sutter, J.	ACME	Daily operations.	*RR00311	NIH		7	74.742	168.867	4.830
Tice, B.	Computation Center	System development and testing.	*RR00311	NIH		7	0.0	0.0	0.002
Vallee, J.	Computation Center	Automation of Stanford Blood Bank.	*RR00311	NIH		7	0.075	0.099	0.038
Vantassel, J.	ACME	Daily operations.	*RR00311	NIH		7	93.105	208.614	1.746
Whitner, J.	ACME	Statistical program development.	*RR00311	NIH		7	0.0	0.0	1.012
Whitner, J.	ACME	Statistical program development.	*RR00311	NIH		7	76.095	278.043	6.378
Wiederhold, G.	ACME	System testing to make sure it meets old and new specifications.	*RR00311	NIH		7	5.562	9.392	6.283
Wiederhold, G.	ACME	Usage statistics, accounting and yearly reports.	*RR00311	NIH		7	0.547	0.768	8.999
Wiederhold, G.	ACME	Developing continuing system modeling program.	*RR00311	NIH		7	7.162	15.820	4.664
Wiederhold, G.	ACME	Demonstrations for visitors to ACME.	*RR00311	NIH		7	8.757	15.216	3.120
Wiederhold, V.	ACME	Editing the PL/ACME manual.	*RR00311	NIH		7	51.677	123.868	10.771
Wilson, D.	ACME	Development of real-time medical procedures.	*RR00311	NIH		7	15.872	52.585	1.743
					TOTAL		1969.938	6163.973	262.117
Biomedical Research,	Real time -- Category 1 (TOTAL)		INDIVIDUAL RESEARCH PROJECTS			1		at .01/2 cent per pageminute	at .10 cents per block
Bacon, V.**	Genetics	Operating quadrupole mass spectrometer.	*NGR5020	NASA	$248,510.70	1	115.705	914.534	32.850
DeGrazia, J.	Nuclear Medicine	Analysis of data collected through a metabolic gas analyzer.	RG69-5	National Academy of Science	1,652.44	1	8.295	23.953	1.428
DeGrazia, J.	Nuclear Medicine	Development of radioisotope techniques for the evaluation of differential kidney function.	None	Public Health Service -- San Francisco	286.79	1	61.412	218.453	5.474
Dong, E.	Cardiovascular Surgery	Examination of cardiac surgery patient data.	None	University Funds	Operating Account	1	64.200	267.466	10.065
Dong, E.	Cardiovascular Surgery	Hemadynamic studies in laboratory animals; effects of heart transplantation.	HE08696	USPHS	60,080.17	1	6.342	17.703	0.907

* Grant supporting more than one user.
**Part of core research.

SUMMARY OF COMPUTER RESOURCE USAGE
INDIVIDUAL USER PROJECTS
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K) at .01/2 cent per pageminute	Block Storage(K) at .10 cents per block
Biomedical Research,	Real time -- Category 1 (TOTAL)								
Dong, E.	Cardiovascular Surgery	General data reduction.	HE13108	USPHS	$ 23,836.08	1	10.605	102.340	5.066
Glick, D.	Pathology	Laser-microprobe element analysis.	HE06716	NIH	58,817.10	1	45.247	157.999	1.957
Hanawalt, P.	Biological Sciences	Use of radioisotope tracers in studies of molecular biology of cell growth and repair of damage to genetic material.	GM09901	NIH	66,863.45	1	67.817	282.907	3.791
Harrison, D.	Cardiology	On-line cardiac catheterization data analysis; recognizing abnormal EKG complexes.	HE09058	NIH	55,907.73	1	46.842	186.240	22.280
Kennedy, D.	Biological Sciences	Analysis of neurophysiological data.	NB02944	NIH	38.10	1	0.0	0.0	0.024
Kohen, R.	Pediatrics	Diagnosis and treatment of statis balance impairment in educationally handicapped school children.	OEG0701263	U.S. Office of Education	64,910.12	1	74.475	408.066	6.037
Kopell, B.	Psychiatry	Studies of Averaged Evoked Responses (AER's)	MH10976-07	NIH	116,258.19	1	14.895	67.269	1.551
Lederberg, J.	Genetics	Automation, operation, and service on the Finnigan 1015 mass spectrometer.	*NGR5020	NASA	248,510.70	1	0.0	0.0	0.002
Lederberg, J.	Genetics	Program instruction; work area for programming and instrumentation use practice.	*NGR5020	NASA	248,510.70	1	0.0	0.0	0.036
Liebes, S.	Genetics	Relationship of mass spectroscopy to organic materials.	*NGR5020	NASA	248,510.70	1	0.0	0.0	0.015
Mazze, R.	Anesthesia	Computer programming to study renal failure in patients.	None	University Funds	Operating Account	1	12.635	37.092	0.646
Morris, S.	Genetics	Analyze the incorporation of radiolabeled amino acids into brain proteins.	GM00295	NIH	130,580.00	1	39.257	164.720	0.892
Pauling, L.	Chemistry	Research on the molecular basis of mental disease.	MH18149	NIMH	96,101.00	1	97.910	440.031	15.924
Reynolds, W.	Genetics	Automation in mass spectrometer instrumentation systems.	*NGR5020	NASA	248,510.70	1	11.087	21.515	5.363
Smith, N.	Anesthesia	Calculating cardiovascular data from normal patients.	*GM12527	NIH	349,661.84	1	10.862	20.367	0.924
Smith, N.	Anesthesia	Data file storage; statistical analyses.	*GM12527	NIH	349,661.84	1	0.0	0.0	0.013
Smythe, H.	Psychiatry	Real-time analysis of electroencephalographic data in all-night sleep EEG's.	MH13860	NIH	203,010.49	1	1.330	1.861	0.180
Stinson, E.	Cardiovascular Surgery	Analysis of hemadynamic data in dogs.	None	Bay Area Heart Research Committee	324.57	1	3.372	50.642	0.545
Sussman, H.	Pathology	Establishment of an automated data processing system for use in clinical pathology laboratories at Stanford University.	None	University Funds	Operating Account	1	32.905	175.144	2.473
Tucker, R.	Genetics	Computer system to control mass spectrometer - GLC apparatus; data analysis.	*NGR5020	NASA	248,510.70	1	0.322	0.464	6.081

* Grant supporting more than one user.

SUMMARY OF COMPUTER RESOURCE USAGE
INDIVIDUAL USER PROJECTS
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Biomedical Research	Real time -- Category 1 (TOTAL)					1		at .01/2 cent per pageminute	at .10 cents per block
Wilson, D.	Biological Sciences	Analysis of neurophysiological data.	NB07631	NIH	$ 40.10	1	0.0	0.0	0.024
					SUB-TOTAL		725.519	3558.766	124.548
Biomedical Research	Routine Terminals -- Category 2 (TOTAL)					2		at .1 cent per pageminute	at .10 cents per block
Aronow, L.	Pharmacology	Laboratory data analysis related to anti-cancer drugs.	None	University Funds	Operating Account	2	2.115	4.173	0.266
Assaykin, T.	Urology	Control of renin secretion.	AM13548	NIH	30,892.61	2	7.600	10.598	0.536
Atkinson, M.	Stanford Medical School - Admissions Committee	Matching the medical students' clerkship requests to the number of clerkships available.	None	University Funds	Operating Account	2	7.882	21.713	0.228
Atkinson, M.	Stanford Medical School - Admissions Committee	Assist Admissions Committee in selecting new Medical School classes.	None	University Funds	Operating Account	2	11.922	22.869	1.770
Atkinson, M.	Stanford Medical School - Admissions Committee	Financial study to see if the Yale medical student loan system for paying for medical school is applicable to Stanford.	None	University Funds	Operating Account	2	2.317	5.753	0.026
Bagshaw, M.	Radiology	Research on patients with radiation therapy.	*CA05838	NIH	592,880.37	2	38.525	165.130	13.526
Bagshaw, M.	Radiology	Radiation dosimetry.	None	American College of Radiology	4.80	2	0.0	0.0	0.020
Baldwin, R.	Biochemistry	Characterization and helix of short DNA helices.	AM04763	NIH	13,609.93	2	1.922	3.058	0.752
Bausek, G.	Medicine - Infectious Diseases	Radiotherapeutic treatment of lymphonas.	*CA05838	NIH	592,880.37	2	4.315	17.355	2.095
Bergstresser, P.	Dermatology	Computation of blood flow in fingers and toes.	None	Special Funds	Special Funds	2	0.255	0.341	0.065
Bodmer, W.	Genetics	Human white blood cells and population genetics.	GM14650	NIH	56,130.15	2	119.182	540.345	35.665
Brown, B.	Community and Preventive Medicine	Conduct various statistical computations in support of research in the Department of Anesthesia.	*GM12527	NIH	349,661.84	2	49.080	142.404	17.444
Brown, B.	Community and Preventive Medicine	Computations done in support of a multitude of public health research projects.	RR5353	University Funds	Operating Account	2	22.455	45.835	8.596
Brown, B.	Community and Preventive Medicine	Development of new biostatistical techniques.	RR5353	University Funds	Operating Account	2	7.205	15.912	2.279
Brutlag, D.	Biochemistry	Studies on the role of divalent metal ions in the reaction mechanism of the enzyme DNA polymerase.	*GM07581	NIH	166,061.80	2	18.435	56.547	1.383

* Grant supporting more than one individual user.

Grant No. RR00311-05
Section IX

SUMMARY OF COMPUTER RESOURCE USAGE
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Biomedical Research,	Routine Terminals —	Category 2 (TOTAL)				2		at .1 cent per pageminute	at .10 cents per block
Cady, P.	Psychiatry	Studying thyroid function in human subjects of varying genetic backgrounds subjected to stress.	MH14528	NIMH	$ 26,464.33	2	33.592	75.383	8.787
Chan, P.	Radiobiology	Simulating the cellular population growth pattern on the computer.	*CA4542-13	NIH	25,964.23	2	2.412	5.659	0.110
Chase, R.	Surgery	Evaluation of facial growth in cleft palate children and determination of velopharyngeal competence.	DE02803	NIH	17,404.53	2	2.200	4.840	0.482
Clayton, R.	Psychiatry	Effects of steroids and hormones of RNA activity on the brain.	*HD00801	NIH	46,712.09	2	2.085	3.065	2.753
Conner, R.	Psychiatry	Experimentation relating neuroendocrine function to behavior.	HD02881	NIH	95,267.43	2	13.725	46.938	0.884
Cooper, J.	Psychiatry	Investigation of biochemical correlates of neonatal sercual differentiation in rats.	*HD00801	NIH	46,710.09	2	11.430	44.115	0.526
Crowley, L.	Surgery	Studying results of antibiotic agents instilled into a wound during surgery.	None	Bristol Labs	8,127.07	2	7.742	17.403	1.564
Doering, C.	Psychiatry	Investigating the causal connections, on a biochemical level, between hormones and behavior in stress.	*HD00801	NIH	46,710.09	2	3.722	7.109	1.789
Fletcher, G.	Anesthesia	Statistical analysis of laboratory results from in-vivo and in-vitro studies of uptake, metabolism, and elimination of sedative drugs	None	John A. Hartford Foundation	3,809.21	2	1.382	5.155	0.024
Forrest, W.	Anesthesia	Development of an inexpensive system of quality and quantity control of large masses of clinical data from several sources.	None	University Funds	Operating Account	2	1.130	2.100	15.170
Forrest, W.	Anesthesia	Maintenance of records concerning surgical operations, and for reports concerning these operations.	None	University Funds	Operating Account	2	2.080	7.300	0.772
Forrest, W.	Anesthesia	Automation of the monthly scheduling of doctors for "on call" duty.	None	University Funds	Operating Account	2	12.020	68.425	1.634
Forrest, W.	Anesthesia	Development of an inexpensive system of quality and quantity control of large masses of clinical data from several sources.	None	University Funds	Operating Account	2	99.670	600.484	44.378
Friedland, G.	Radiology	Determination of the action of the gastric sling fibers.	GM01707	NIH	7,383.41	2	8.852	31.525	1.858
Fries, J.	Medicine - Immunology	Establishment of a large databank of clinical information and exploration of multiple uses of such stored information.	None	University Funds	Operating Account	2	55.505	133.155	12.833
Goldstein, A.	Pharmacology	Mechanism of the action of narcotics and the fundamental aspects of narcotic addiction.	*MH13963	NIH	119,928.41	2	7.420	16.877	0.531
Goldstein, A.	Pharmacology	Statistical procedures for laboratory studies on morphine.	*MH13963	NIH	119,928.41	2	10.945	20.329	0.269

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Biomedical Research,	Routine Terminals	-- Category 2 (TOTAL)				2		at .1 cent per pageminute	at .10 cents per block
Goldstein, D.	Pharmacology	Establishment of essential parameters for enzyme kinetics in inhibition of flavin enzymes by barbiturates.	*MH13963	NIH	$119,928.41	2	20.130	51.415	0.492
Herzenberg, L.	Genetics	Collating multiple mouse immunoglobulin levels; storage of data and direct anti-serum production.	HD01287	NIH	14,095.31	2	0.325	0.800	3.880
Herzenberg, L.	Genetics	Collating multiple mouse immunoglobulin levels; storage of data and direct anti-serum production.	HD01287	NIH	14,095.31	2	0.582	2.350	0.431
Herzenberg, L.	Genetics	Collating multiple mouse immunoglobulin levels; storage of data and direct anti-serum production.	HD01287	NIH	14,095.31	2	3.680	5.888	1.220
Hogness, D.	Biochemistry	Analysis of experimental data on chromosome fragments in Drosophila.	AM07535	NIH	49,472.81	2	3.775	7.777	0.185
Huberman, J.	Biochemistry	Reducing data from equilibrium dialysis.	*GM07581	NIH	166,061.80	2	0.722	1.296	0.270
Jovin, T.	Biochemistry	Data reduction and generation of systems for electrophonic separations based upon theoretical models.	*GM07581	NIH	166,061.80	2	1.782	3.271	0.196
Kallman, R.	Radiobiology	Analysis of data relating to the survival of experimental tumor cells to the dose of irradiation received by the cells.	CA3353	NIH	12,268.85	2	1.019	24.110	0.032
Kendig, J.	Anesthesia	Research on data relating to the effects of drugs on skeletal muscle-resting potential.	*GM12527	NIH	349,661.84	2	1.582	2.123	0.046
Kessler, S.	Psychiatry	Analysis of mating speed experiments.	MH14364	NIH	20,759.69	2	4.475	6.683	0.233
Koran, L.	Psychiatry	Relationship of student test scores to other variables.	None	University Funds	Operating Account	2	0.0	0.0	0.004
Kraemer, H.	Psychiatry	Biostatistical analysis of various psychological data.	None	University Funds	Operating Account	2	41.297	84.580	6.980
Kriss, J.	Nuclear Medicine	Calculation of plasma volume, blood volume and red cell mass in patients who receive radioactive tracer material.	AM07642	NIH	25,858.15	2	0.007	0.008	0.021
Kriss, J.	Nuclear Medicine	Studies on the pathogenesis of Graves' disease, and the effects of X-ray therapy upon thyroid function.	AM07642	NIH	25,858.15	2	23.255	63.099	3.154
Laipis, P.	Genetics	Experiments on sucrose and cesium chloride gradients in the ultracentrifuge.	GM14108	NIH	29,480.93	2	0.017	0.035	0.153
Lamb, E.	Gynecology and Obstetrics	Calculation of relative potency and confidence limits of total gonadotropin activity of human urine extracts.	None	University Funds	Operating Account	2	7.987	16.340	1.134
Lederberg, J.	Genetics	Statistical and miscellaneous programs used by the Genetics Department.	*GM00295	NIH	130,580.00	2	0.057	0.125	1.495
Lederberg, J.	Genetics	Processing of chromosome data.	None	University Funds	Operating Account	2	0.137	0.284	0.001

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Biomedical Research,	Routine Terminals	- Category 2 (TOTAL)				2		at .1 cent per pageminute	at .10 cents per block
Lederberg, J.	Genetics	Generating of chemical structures and displays on the Sanders 720 by interfacing.	*NGR0502	NASA	$248,510.70	2	0.212	0.401	0.150
Lehman, I.	Biochemistry	Statistical analysis of experimental data.	GM06196	NIH	60,568.83	2	2.077	3.654	0.118
Leiderman, P.	Psychiatry	Studies of maternal behavior in non-human mammals.	HD02636	NIH	64,122.92	2	2.440	4.481	0.427
Levinthal, E.	Genetics	Photointerpretation and enhancement.	*NGR5020	NASA	248,510.70	2	0.0	0.0	0.018
Liebes, S.	Genetics	Investigating means of data processing for interpretation of photographic data from the Mariner Mars 1971 Orbiter program.	*NGR5020	NASA	248,510.70	2	0.0	0.0	0.008
Liebes, S.	Genetics	Design aspects of imagery system to be landed on surface of Mars in course of Viking 1973 Lander Mission.	*NGR5020	NASA	248,510.70	2	0.0	0.0	0.008
Lieberman, M.	Psychiatry	Measurement of the efficacy of "small groups" in education.	None	University Funds	Operating Account	2	0.0	0.0	0.008
Lorenson, M.	Pharmacology	Molecular mechanisms that control sheep-heart enzyme and carbohydrate metabolism.	AI04214	NIH	15,105.75	2	0.0	0.0	0.032
Luetscher, J.	Medicine - Metabolic Research	Secretion and metabolism of adrenal hormones	AM03062	NIH	36,971.08	2	17.912	35.260	1.903
Luzzati, L.	Pediatrics	Study family with chromosomal mosaicism in three generations.	CRCS407	National Foundation	10,103.01	2	6.297	13.117	2.561
Maffly, R.	Medicine - Lipid Research	Evaluation of acid-base disorders in patients	None	University Funds	Operating Account	2	4.867	21.476	1.462
Maffly, R.	Medicine - Lipid Research	Relationship of metabolism to sodium transport.	67627	American Heart Association	79.29	2	8.547	29.776	0.283
Melges, F.	Psychiatry	Understanding psychotic processes.	MH29163	NIH	20,088.86	2	7.755	12.549	2.403
Miller, R.	Community and Preventive Medicine	Biostatistical research and/or education.	GM00025	NIH	13,539.94	2	0.002	0.0	0.013
Miller, R.	Community and Preventive Medicine	Teaching of courses in biostatistics.	GM00025	NIH	13,539.94	2	0.722	3.493	0.484
Morris, R.	Surgery	Reduction of cell death of a target cell monolayer by specifically sensitized lymphocytes.	GM01922	NIH	18,449.88	2	2.310	3.751	0.070
Nall, L.	Dermatology	Etiology of chronic skin disease.	None	University Funds	Operating Account	2	4.110	5.784	1.410
Nelsen, T.	Surgery	Clinical cancer research record protocols and data for storage and analysis.	*CA08122	NIH	726.32	2	0.450	0.977	1.929
Nye, W.	Medical Microbiology	Statistical calculations and bibliography compilations in immunochemistry.	*AI08211	NIH	7,270.21	2	2.800	4.493	0.214

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Biomedical Research,	Routine Terminals	- Category 2 (TOTAL)				2		at .1 cent per pageminute	at .10 cents per block
Nye, W.	Medical Microbiology	Immunochemistry statistical calculations and bibliography compilations.	*AI08211	NIH	$ 7,270.21	2	4.322	7.174	0.388
Ostrem, D.	Biochemistry	Analysis of data obtained from experiments with the enzyme glycl-TRNA synthetase.	GM13235	NIH	63,356.29	2	1.650	2.303	0.095
Payne, R.	Medicine - Hematology	Extending leukocyte and/or tissue antigen classification by serologic and genetic analysis.	HE03365	NIH	30,848.29	2	20.262	130.808	6.277
Petralli, J.	Medicine - Infectious Disease	Antiobiotic-sensitivity testing in the treatment of specific infections.	None	University Funds	Operating Account	2	148.615	309.744	40.874
Rapp, W.	Medicine	Immunological determination of the gastric antigenic esterase VI A in gastric juices of patients with different gastric diseases.	AM06971	NIH	14,131.20	2	1.525	2.289	0.277
Reaven, G.	Medicine - Lipid Research	On-line display procedure to determine physiological models of metabolic processes.	AM05972	NIH	13,755.34	2	73.585	152.182	4.250
Reaven, G.	Medicine - Lipid Research	Relationship between glucose, insulin, and triglyceride kinetics and diabetes mellitis and arthereosclerosis.	HE08506	NIH	17,314.40	2	7.430	20.504	0.822
Reitan, J.	Anesthesia	Processing cardiac interval timing to monitor contractile state under varying loads and drugs.	GM00862	NIH	18,161.96	2	0.207	0.702	3.115
Reynolds, W.	Genetics	Text management to support engineering instrumentation.	*NGR5020	NASA	248,510.70	2	0.112	0.174	2.832
Reynolds, W.	Genetics	Text editing for computer instrumented checkout of scientific instruments designed to fly on the Viking 75 mission to Mars.	RC0446200	NASA	3,040.48	2	0.0	0.0	0.005
Robertson, W.	Pediatrics	Urinary analysis; data on immunoglobulin concentration.	AI8490	NIH	11,210.28	2	5.330	9.246	1.917
Rosenberg, L.	Medical Microbiology	Statistical analyses and calculations on the serum complement in mice.	AI09341	NIH	19,328.36	2	4.185	8.966	1.288
Rosenberg, S.	Medicine - Oncology	Correlating drug responsiveness in cancer patients.	*CA08122	NIH	68,595.72	2	42.730	159.424	5.834
Russel, A.	Biochemistry	Routine calculations on enzyme assays.	*GM07581	NIH	166,061.80	2	4.302	10.717	0.277
Schneiderman, L.	Medicine - Ambulatory	Clinical research data indexing.	None	University Funds	Operating Account	2	0.577	2.471	4.369
Schubert, S.	Speech and Hearing	Analysis of signal waveforms by Fourier, correlational and similar techniques.	NS7554	USPHS	11,525.79	2	0.0	0.0	0.012
Shaw, N.	Orthopedic Surgery	Calculations of vehicle dynamics, occupant kinematics, and loading for multidisciplinary investigation of automobile crashes.	FH11-7583	National Highway Safety Bureau	2,603.01	2	0.575	0.809	0.031
Simpson, J.	Physics	Design work for a superconducting magnetic beam transport channel for use in pion cancer therapy.	GP27708	NSF	1,692.83	2	32.340	129.585	1.340

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Biomedical Research,	Routine Terminals	- Category 2 (TOTAL)				2		at .1 cent per pageminute	at .10 cents per block
Smallwood, R.	Medical Facilities Planning	Design of Stanford Medical Care Facilities.	None	University Funds	Operating Account	2	0.930	1.820	4.243
Smith, J.	Medical Microbiology	Development of a system for automatic classification of human chromosomes.	69-2053	NIH	$199,666.48	2	10.455	32.894	0.379
Smith, J.	Medical Microbiology	Development of a system for automatic classification of human chromosomes.	69-2053	NIH	199,666.48	2	0.0	0.0	0.003
Smith, K.	Radiology	Data analysis of sedimentation patterns of DNA following X-irradiation.	CA10372	NIH	210,413.43	2	13.064	23.169	0.286
Solomon, G.	Psychiatry	Relationship of various forms of stress and environmental manipulation to immunity.	None	University Funds	Operating Account	2	2.640	4.638	0.187
Spevac, A.	Psychiatry	Analysis of data from behavioral and neuro-physiological experiments in monkeys and cats.	MH08304	NIH	11,745.31	2	2.745	8.313	0.996
Stark, G.	Biochemistry	Analysis of data on enzyme experiments and processing of chromatograms generated by an amino acid analyzer.	GM11788	NIH	8,717.61	2	6.462	10.548	2.066
Stocker, B.	Medical Microbiology	Genetics and physiology of salmonella typhimurium.	AI08942	NIH	14,899.59	2	5.962	15.369	8.832
Strickland, R.	Medicine - G.I. Division	Analyzing gastric secretory function tests.	AM05418	NIH	6,067.32	2	0.0	0.0	0.421
Stuedeman, D.	Genetics	Capital equipment inventory.	*NGR5020	NASA	248,510.70	2	2.560	5.070	1.997
Sussman, H.	Pathology	Statistical analysis of the data generated in the clinical lab.	None	University Funds	Operating Account	2	27.477	40.971	1.174
Swartout, W.	Community and Preventive Medicine	Evaluation of the effects of air pollution on student health.	None	University Funds	Operating Account	2	0.0	0.0	0.010
Vosti, K.	Medicine - Infectious Diseases	Cross-tabulating variables associated with bacterial infections.	AI03638	NIH	27,559.80	2	2.557	4.620	2.079
Weissman, I.	Pathology	Statistical analysis and data handling.	AI09072	NIH	41,997.32	2	11.340	19.389	0.654
Whitcher, C.	Anesthesia	Computerization of the anesthesia call schedule.	None	University Funds	Operating Account	2	0.037	0.176	0.375
Wilson, J.	Regional Medical Program	Development of a county wide (Santa Cruz) registry on stroke patients; development of a population base for study and analysis.	None	Stanford Stroke Program	Operating Account	2	45.222	211.975	4.743
Wilson, J.	Regional Medical Program	Analysis of data from registry on stoke patients.	None	Stanford Stroke Program	Operating Account	2	2.505	7.001	0.123
Zackheim, H.	Dermatology	Determination of serum copper and cerulo-plasmin levels in psoriasis patients.	None	Hartford Foundation	63,037.90	2	0.0	0.0	0.268
					SUB-TOTAL		1222.173	3862.556	315.280

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Non-Stanford, Medical -- Category 3 (TOTAL)						3		at .2 cents per pageminute	at .10 cents per block
Belt, D.	Speech and Hearing			None		3	0.0	0.0	0.002
Daughters, G.	Palo Alto Medical Research Foundation			Foundation Funds		3	5.970	8.352	0.286
Daughters, G.	Palo Alto Medical Research Foundation			Foundation Funds		3	2.215	3.341	0.409
Daughters, G.	Palo Alto Medical Research Foundation			Foundation Funds		3	4.612	8.896	1.195
Durbridge, T.	Pathology			None		3	13.375	40.079	0.617
Enlander, D.	Pathology			None		3	1.355	3.087	0.868
Ingels, N.	Palo Alto Medical Research Foundation			Foundation Funds		3	0.022	0.051	0.253
Kountz, S.	San Francisco Medical Center			S.F. Medical Center Funds		3	11.427	84.723	1.530
Stewart, L.	Palo Alto Medical Research Foundation			Foundation Funds		3	0.0	0.0	0.013
Tickner, E.	Palo Alto Medical Research Foundation			Foundation Funds		3	0.032	0.058	0.295
Tickner, E.	Palo Alto Medical Research Foundation			Foundation Funds		3	1.045	3.893	0.256
					SUB-TOTAL		40.055	152.482	5.724
Student Education, Medical School -- Category 4 (FREE)						4		at .1 cent per pageminute	at .10 cents per block
Brast, N.	Medical Student	Calculating descriptive and inferential statistics on experimental data.	*RR00311	NIH		4	4.145	10.704	2.177
Britt, R.	Medical Student	Auditory pathway responses to acoustic stimuli.	*RR00311	NIH		4	0.007	0.010	0.164
Brody, B.	Medical Student	History taking and formulation of differential diagnoses.	*RR00311	NIH		4	1.717	5.695	0.299
Brody, B.	Medical Student	Information processing in sensory systems.	*RR00311	NIH		4	0.580	0.808	2.195
Brown, B.N.	Medical Student	Correlating serum levels of therapeutic agents with age, body weight, surface area, etc.	*RR00311	NIH		4	1.982	4.612	5.801
Brown, B.W.	Medical Student	Computer instruction in biostatistics.	*RR00311	NIH		4	14.397	27.765	1.923
Buchanan, B.	Medical Student	Determine whether medical students can learn statistical concepts by computer simulation.	*RR00311	NIH		4	22.357	44.540	3.425

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Student Education,	Medical School -- Category 4 (FREE)					4		at .1 cent per pageminute	at .10 cents per block
Buchanan, B.	Medical Student	Computer instruction for medical students in Genetics Department.	*RR00311	NIH		4	44.042	105.035	2.052
Calvert, J.	Medical Student	Devising mathematical models to be used for public administration.	*RR00311	NIH		4	0.252	0.351	1.818
Chester, J.	Medical Student	Calculation of data on tumors in mice.	*RR00311	NIH		4	11.017	26.978	1.003
Chu, F.	Medical Student	Automatic recognition of cardiac arrby turmas on monitored patients.	*RR00311	NIH		4	16.345	33.571	1.488
Corby, J.	Medical Student	Relationship between attention and enhancement of averaged evoked response (AER) magnitude.	*RR00311	NIH		4	18.727	38.480	1.100
Dimsdale, J.	Medical Student	Characterize psychiatric wards on the basis of certain commonly-held values - in particular, goals of therapy.	*RR00311	NIH		4	6.582	14.714	0.564
Enzmann, D.	Medical Student	Determination of secondary peristalsis of the esophagus.	*RR00311	NIH		4	7.975	20.521	11.437
Feldman, G.	Medical Student	Monitor airway resistance values during sessions with asthmatic patients and normal subjects.	*RR00311	NIH		4	3.595	8.534	0.133
Gamel, J.	Medical Student	Indicator dilution techniques for measuring pulmonary blood flow and lung transfer function.	*RR00311	NIH		4	10.220	26.111	5.921
Gelfan, M.	Medical Student	On-line analysis of cardiac catheterization data.	*RR00311	NIH		4	3.657	6.490	1.304
Gleason, C.	Medical Student	Self-education: how to use computers in electrophysiological research.	*RR00311	NIH		4	7.330	42.822	0.803
Gordon, L.	Medical Student	Monte Carlo generation of random variables for examining efficiency of confidence intervals.	*RR00311	NIH		4	3.575	12.837	0.016
Hahn, P.	Medical Student	Interpretation, quantification, and systematic retrieval of information from gel electrophöreses.	*RR00311	NIH		4	2.765	14.412	1.179
Harris, R.	Medical Student	Correlation between human emotions and their appraisals of their environment.	*RR00311	NIH		4	3.502	5.971	2.113
Helikson, M.	Medical Student	Evaluating liver blood flow with radioactive isotopes.	*RR00311	NIH		4	12.290	41.033	14.956
Jan, W.	Medical Student	Statistical tests on data from laboratory experiments.	*RR00311	NIH		4	48.522	143.577	1.689
Known, U.N. (Miscellaneous Users)	Medical Student	Minor student desk calculator services; no file storage.	*RR00311	NIH		4	910.907	2100.288	0.050
Levine, R.	Medical Student	Studies on the complicated kinetics of the carbamoyl phosphate synthetase; search for control mechanism of this enzyme.	*RR00311	NIH		4	27.030	102.151	3.985

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Student Education, Medical School -- Category 4 (FREE)						4		at .1 cent per pageminute	at .10 cents per block
Lipp, M.	Medical Student	Survey of medical students and graduate physicians regarding their experience with and opinions of marihuana.	*RR00311	NIH		4	21.617	102.762	12.216
Miller, S.	Medical Student	Computer diagnosis of liver and cardiac disease.	*RR00311	NIH		4	0.372	2.275	9.358
Nestor, L.	Medical Student	Establishment of computer-based program aimed at differential diagnosis.	*RR00311	NIH		4	5.137	19.092	1.473
Nola, G.	Medical Student	Perform statistical analysis of hemodynamic parameters.	*RR00311	NIH		4	13.695	21.131	0.353
Nuwer, M.	Medical Student	Modeling the operations of large sets of neurons to approximate the action of the nervous system.	*RR00311	NIH		4	0.0	0.0	0.002
Odell, R.	Medical Student	Studies on the interaction of hormonal and neural events to discover signals in the operation of the physiological system.	*RR00311	NIH		4	0.0	0.0	0.004
Peters, D.	Medical Student	Formulation of a comprehensive model for insulin metabolism within the human body.	*RR00311	NIH		4	8.910	32.906	0.358
Peters, J.	Medical Student	Evaluation of residuals and outliers in parallel line assays.	*RR00311	NIH		4	20.520	68.542	2.225
Pope, S.	Medical Student	Statistical analysis of data sets of cardio-vascular function parameters of various pharmaecologic agents.	*RR00311	NIH		4	2.205	3.950	0.353
Portlock, C.	Medical Student	Study of motivations for pregnancy.	*RR00311	NIH		4	0.0	0.0	0.012
Propper, R.	Medical Student	Study of inter-relationship of annogenesis glucomedgenesis in the perfused kidney.	*RR00311	NIH		4	0.080	0.096	0.327
Raybin, D.	Medical Student	Calculate results of assays and handle other data calculations, statistics, etc.	*RR00311	NIH		4	5.290	9.009	0.102
Rosenfeld, R.	Medical Student	Studying the psychophysiological adaptation of male patients to the Coronary Care Unit.	*RR00311	NIH		4	0.0	0.0	0.024
Rosenthal, W.	Medical Student	Speech and language pathology; normal speech perception.	*RR00311	NIH		4	0.057	0.113	0.617
Sachs, D.	Medical Student	Studies on ecology and population biology.	*RR00311	NIH		4	39.210	91.692	16.126
Saffir, A.	Medical Student	Computer instruction in biostatistics for dental students.	*RR00311	NIH		4	1.352	2.211	0.008
Scandella, C.	Medical Student	Studying a phospholipase enzyme which has been purified from cell membranes.	*RR00311	NIH		4	17.375	28.277	1.057
Schwartz, B.	Medical Student	Statistical modeling of the growth, development, and ultimate senescence of cultured human fibroblasts.	*RR00311	NIH		4	0.600	1.156	0.093
Sethi, S.	Medical Student	Studies on the replication of rhinoviruses.	*RR00311	NIH		4	0.850	2.083	0.912

* Grant supporting more than one individual user.

SUMMARY OF COMPUTER RESOURCE USAGE
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INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Student Education, Medical School -- Category 4 (FREE)						4		at .1 cent per pageminute	at .10 cents per block
Sinclair, A.	Medical Student	Measurement of intervals between beats of individual heart cells and administering drugs to cells to change environmental conditions.	*RR00311	NIH		4	4.470	9.870	0.443
Smith, R.	Medical Student	Experimental study of family structure; socio-physiological studies of kidney transplant patients.	*RR00311	NIH		4	0.0	0.0	0.604
Swanson, G.**	Medical Student	Interpret therapeutic drug action on respiratory control.	*RR00311	NIH		4	138.842	631.767	27.342
Thomas, H.	Medical Student	Student decisions under a time constraint.	*RR00311	NIH		4	1.645	3.114	0.112
Wiskocil, B.	Medical Student	Studying the enzyme mechanism of tryptophan synthesis; using equilibrium dialysis technique.	*RR00311	NIH		4	0.0	0.0	0.009
					SUB-TOTAL		1465.752	3868.062	141.725
Core Research, Real time -- Category 5 (FREE)						5		at .01/2 cent per pageminute	at .10 cents per block
Reynolds, W.**	Genetics	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analyses.	*RR00311	NIH		5	89.817	257.154	18.445
Ross, R.**	Chemistry	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analyses.	*RR00311	NIH		5	55.612	578.243	15.123
Stillman, R.**	Chemistry	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analyses.	*RR00311	NIH		5	33.442	166.208	10.430
					SUB-TOTAL		178.872	1001.606	43.998
Core Research, Routine Terminals -- Category 6 (FREE)						6		at .1 cent per pageminute	at .10 cents per block
Cohen, S.**	Clinical Pharmacology	Establishment of computer-based program aimed at preventing undersirable drug interactions.	*RR00311	NIH		6	100.925	391.933	20.141
Reynolds, W.**	Genetics	Recording of high and low resolution mass spectra; computer control of the operating parameters of mass spectrometers.	*RR00311	NIH		6	9.112	46.108	0.300
Ross, R.**	Chemistry	Recording of high and low resolution mass spectra; computer control of the operating parameters of mass spectrometers.	*RR00311	NIH		6	23.067	105.109	2.125
Stefik, M.**	Genetics	Development of programs for Mass Spectrometer; Mass Spectrometer will be used for deducing molecular structure.	*RR00311	NIH		6	39.757	177.200	2.088
Stillman, R.**	Chemistry	Development of programs for Mass Spectrometer.	*RR00311	NIH		6	15.052	73.844	0.400
					SUB-TOTAL		187.915	794.196	25.054

* Grant supporting more than one individual user.
**Part of core research.

Grant No. RR00311-05
Section IX

SUMMARY OF COMPUTER RESOURCE USAGE
INDIVIDUAL USER PROJECTS
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Stanford Medical School, Clinic Billing Office -- Category 8 (TOTAL)						8		at .1-1/4 cents per pageminute	at .10 cents per block
Boyle, J.	Clinic Billing Office		University Funds	University Operating Account		8	246.112	1399.622	93.747
					SUB-TOTAL		246.112	1399.622	93.747
Pilot Project, Real time -- Category 10 (FREE)						10		at .01/2 cent per pageminute	at .10 cents per pageminute
Borison, S.	Cardiovascular Surgery	Simulation of various properties of the physiological system.	*RR00311	NIH		10	4.375	11.160	0.082
MacPherson, L.	Psychiatry	Studies of Averaged Evoked Responses (AER's).	*RR00311	NIH		10	0.887	2.398	0.0
MacPherson, L.	Psychiatry	Comparison of EEG responses evoked by visual stimuli incorporating a direction component in dyslexic and normal children.	*RR00311	NIH		10	17.402	96.610	9.368
Newman, N.	Psychiatry	Establishment of a computer-based laboratory information system at the Stanford Medical Center.	*RR00311	NIH		10	14.420	80.615	0.563
Sherwood, S.	Neurology	Understanding of electroencephalographic phenomena.	*RR00311	NIH		10	0.0	0.0	0.018
Sussman, H.**	Pathology	Establishment of a computer-based laboratory information system at the Stanford Medical Center.	*RR00311	NIH		10	7.662	35.421	0.182
Sussman, H.**	Pathology	Connecting a large instrument in the Clinical Laboratory to the 1800 for data collection.	*RR00311	NIH		10	0.372	0.552	0.009
					SUB-TOTAL		45.120	226.758	10.222
Pilot Project, Routine Terminals -- Category 11 (FREE)						11		at .1 cent per pageminute	at .10 cents per block
Belt, D.	Speech and Hearing	Data collection and analysis from hearing and vision testing on elementary school children.	*RR00311	NIH		11	21.455	67.731	5.196
Bunnenberg, E.	Chemistry	Utilization of organic chemical and bio-chemical applications of magnetic circular dichroism.	*RR00311	NIH		11	3.135	16.729	5.521
Butler, E.	Urology	Creation of a uniform method of information retrieval and computer-based data processing for statistical reports.	*RR00311	NIH		11	18.652	110.578	9.850
Cavalli, L.	Genetics	Simulations of populations and subsequent predictions about evolutionary processes.	*RR00311	NIH		11	15.767	56.286	0.281
Costell, R.	Psychiatry	Analysis and statistical testing of factors of significance in the sexual histories of sex offenders.	*RR00311	NIH		11	4.175	7.124	0.296

* Grant supporting more than one individual user.
**Part of core research.

SUMMARY OF COMPUTER RESOURCE USAGE
INDIVIDUAL USER PROJECTS
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INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT: Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT: Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Pilot Project, Routine Terminals -- Category 11 (FREE)						11		at .1 cent per pageminute	at .10 cents per block
Eddy, D.	Cardiovascular Surgery	Development of an optimization technique for control of infectious diseases.	*RR00311	NIH		11	0.0	0.0	0.002
Goldstein, A.	Pharmacology	Periodic data summation and statistical tests on the use of methadone in treating heroin addicts.	*RR00311	NIH		11	12.627	65.424	1.621
Henry, P.	Psychiatry	Development of pattern recognition subroutines to identify and count monophasic sharp waves recorded from the lateral geniculate during sleep.	*RR00311	NIH		11	4.842	16.424	1.079
Hillman, R.	Psychiatry	Construct computerized psychiatric "patient."	*RR00311	NIH		11	0.732	1.902	0.146
Hirschfeld, R.	Psychiatry	Applications of Bayes' Theorem to psychiatric diagnosis.	*RR00311	NIH		11	7.915	17.072	5.667
Kallman, R.	Radiobiology	Analysis of tumor blood flow data from experiments on rodent tumors.	*RR00311	NIH		11	7.192	12.957	2.759
Korn, D.	Pathology	Data retrieval of autopsy records.	*RR00311	NIH		11	13.662	27.976	15.730
Leiderman, P.	Psychiatry	Analysis of data collected from a village in Kenya on physical, psychological, and social growth of infants during their first year of life.	*RR00311	NIH		11	0.0	0.0	0.004
McGann, L.	Community and Preventive Medicine	Survey of Stanford Medical Center hospital charges for the aged.	*RR00311	NIH		11	0.0	0.0	0.318
Morrell, L.	Neurology	Multivariate statistical evaluation of data relating electroencephalographic measures to motor behavior.	*RR00311	NIH		11	2.900	9.206	6.207
Steward, P.	Radiology	Studying the kinetic responses in tumor and normal tissues; determination of the most promising radiochemotherapy protocols.	*RR00311	NIH		11	6.767	19.254	0.847
					SUB-TOTAL		119.825	428.667	55.522
Funding Anticipated, Real time -- Category 12 (FREE)						12		at .01/2 cent per pageminute	at .10 cents per block
Constantinou, C.	Urology	Studies on the improvement of clinical appraisal, follow up and management of patients with neurogenic bladder dysfunction.	*RR00311	NIH		12	97.052	314.048	11.562
Gersch, W.	Neurology	Research in the application of time series methods to problems in neurophysiology and medicine.	*RR00311	NIH		12	63.675	344.476	17.524
Glaze, H.	Cardiovascular Surgery	Computation of data obtained from experiments on the vagal-cardiac rate system of dogs.	*RR00311	NIH		12	12.507	80.054	5.074
Govan, D.	Urology	Information storage and retrieval of data on patients with spinal cord injury or disease.	*RR00311	NIH		12	52.985	212.734	10.115
Thathachari, Y.	Dermatology	Generation of models of the molecular structure of melanins.	*RR00311	NIH		12	39.945	197.193	3.043
* Grant supporting more than one individual user.					SUB-TOTAL		266.165	1148.506	47.318

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SUMMARY OF COMPUTER RESOURCE USAGE
INDIVIDUAL USER PROJECTS
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Funding Anticipated,	Routine Terminals --	Category 13 (FREE)				13		at .1 cent per pageminute	at .10 cents per block
Cann, H.	Pediatrics	Investigation of factors which affect frequencies of genes controlling various human heritable characters.	*RR00311	NIH		13	6.875	19.237	0.280
Cann, H.	Pediatrics	Investigation of factors which affect frequencies of genes controlling various human heritable characters.	*RR00311	NIH		13	74.107	231.296	16.944
DeNardo, G.	Nuclear Medicine	Using radioactive methods to assess regional distribution of ventilation and pulmonary blood flow.	*RR00311	NIH		13	0.642	0.965	0.691
Doherty, R.	Pediatrics	Random sampling of cells; statistical evaluation of data.	*RR00311	NIH		13	26.375	87.315	19.739
Kopell, B.	Psychiatry	Relationship between average evoked potential expectancy wave, and EEG in humans.	*RR00311	NIH		13	14.465	61.773	6.099
Saunders, A.	Pathology	Chemistry of single cell; maturation and biology of mast cell.	*RR00311	NIH		13	0.0	0.0	0.006
Saunders, A.	Pathology	Measurement of cells by a rapid censor system.	*RR00311	NIH		13	0.0	0.0	0.633
Savageau, M.	Cardiology	Kinetic behavior of enzyme catalyzed reactions.	*RR00311	NIH		13	0.737	1.588	0.122
					SUB-TOTAL		123.202	402.175	44.514
Suspended Pending Individual	Institute Approval --	Category 14 (TOTAL)				14		at .01/2 cent per pageminute	at .10 cents per block
Bunnenberg, E.	Chemistry	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analysis.	*GM12173	NIH	$ 22,142.97	14	0.130	0.202	2.003
Bunnenberg, E.	Chemistry	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analysis.	*GM12173	NIH	22,142.97	14	0.005	0.008	3.705
Bunnenberg, E.	Chemistry	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analysis.	*GM12173	NIH	22,142.97	14	1.997	3.442	0.059
Dong, E.	Cardiovascular Surgery	Effects of heart transplants; white cell correlations; pulmonary data collection.	PH436711	NIH	23,836.08	14	41.682	179.069	11.522
Dong, E.	Cardiovascular Surgery	Development of a controller for an artificial heart.	PH436711	NIH	89,735.53	14	39.887	380.119	10.001
Duffield, A.	Chemistry	Analysis of mass spectra and spectropolorimeter spectra; routine chemical analysis.	*GM12173	NIH	22,142.97	14	7.575	116.214	2.293
Warrick, G.	Psychiatry	Analysis of continuous EEG for averaged evoked responses.	*MH10976	NIMH	116,258.19	14	0.0	0.0	0.029
Wittner, W.	Psychiatry	Influence of correctly and incorrectly guessed visual patterns on visual average evoked response.	*MH10976	NIMH	116,258.19	14	0.005	0.007	0.012
					SUB-TOTAL		91.283	679.063	29.624

* Grant supporting more than one individual user.

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SUMMARY OF COMPUTER RESOURCE USAGE
INDIVIDUAL USER PROJECTS
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Suspended Pending Institute Approval, Routine Terminals -- Category 15 (TOTAL)						15		at .1 cent per pageminute	at .10 cents per block
Bernfield, M.	Pediatrics	Biochemistry in birth defects.	HD02147	NIH	$198,232.79	15	0.382	1.308	0.244
Efron, B.	Community and Preventive Medicine	Theoretical and applied research in bio-statistics.	GM14554	NIH	2,740.46	15	7.820	17.135	0.632
Hahn, G.	Radiology	Study of radiochemotherapy of mammalian cell cultures.	*CA04542	NIH	10,780.23	15	0.230	0.605	0.264
Hilf, F.	Psychiatry	Interactive on-line psychological testing.	*MH11028	NIH	54,863.08	15	0.042	0.042	1.666
Smith, P.	Anesthesia	Premature or sick newborn infant research.	RR00081	NIH	163,057.22	15	0.002	0.000	0.632
Stillman, R.	Psychiatry	Interviewing and testing psychiatric patients.	*MH11028	NIH	54,863.08	15	0.050	0.148	1.488
					SUB-TOTAL		8.527	19.153	4.926
					TOTAL		4720.520	17522.459	942.202

* Grant supporting more than one individual user.

SUMMARY OF COMPUTER RESOURCE USAGE
OTHER USE (Non-health related use)
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Stanford Non-Medical	School and Non-Biomedical Research -- Category 9 (TOTAL)					9		at .2-1/2 cents per pageminute	at .10 cents per block
Astro, A.	Aero and Astro					9	0.435	1.432	0.659
Astro, A.	Aero and Astro					9	7.575	24.923	1.764
Balcer, Y.	Operations Research					9	0.0	0.0	0.002
Boyd, W.	School of Law					9	4.835	34.248	0.342
Brown, S.	Psychology					9	0.0	0.0	0.006
Fork, D.	Carnegie Institute					9	1.292	2.051	0.482
Greene, D.	Psychology					9	0.265	0.469	0.013
Gustavson, D.	Stanford Linear Accelerator Center					9	39.610	93.947	10.215
Hardwick, J.	School of Business					9	0.0	0.0	0.010
Harris, W.	Philosophy					9	0.0	0.0	0.005
Jacklin, C.	Psychology					9	1.732	2.490	0.036
Johansen, D.	Aero and Astro					9	9.492	17.976	1.961
Jurow, J.	Stanford Linear Accelerator Center					9	4.140	6.110	1.538
Lepper, M.	Psychology					9	0.080	0.114	0.015
Maccoby, E.	Psychology					9	0.165	0.227	0.017
Margel, D.	Materials Science					9	0.380	0.819	0.060
McConnell, H.	Chemistry					9	19.122	120.825	0.152
Naumes, W.	School of Business					9	8.042	28.064	2.874
Nelson, K.	Psychology					9	0.182	0.254	0.013
Patterson, F.	Psychology					9	0.045	0.067	0.006
Rees, J.	Stanford Linear Accelerator Center					9	11.057	21.751	1.207
Richter, B.	Stanford Linear Accelerator Center					9	11.545	23.287	4.190
Ritson, D.	Physics					9	30.217	55.160	3.250
Saal, H.	Stanford Linear Accelerator Center					9	0.182	0.716	0.413
Schawlow, A.	Physics					9	0.317	0.639	0.443
Sears, R.	Psychology					9	1.407	1.975	0.036
Sears, R.	Psychology					9	0.510	0.716	0.042
Shapiro, S.	Statistics					9	1.237	3.528	0.160

SUMMARY OF COMPUTER RESOURCE USAGE
OTHER USE (Non-health related use)
Period Covered 4/17/70 - 4/16/71

INVESTIGATOR	DEPARTMENT INSTITUTION	PROJECT TITLE	DIRECT GRANT OR CONTRACT SUPPORT Identification Number	Agency	Current Annual Amt.	User Category	COMPUTER EQUIPMENT Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
Stanford Non-Medical	School and Non-Biomedical Research -- Category 9 (TOTAL)					9		at .2-1/2 cents per pageminute	at .10 cents per block
Walker, E.	Psychology					9	3.047	4.310	0.053
Wiederhold, G.	INDEX					9	0.345	0.493	1.697
Wiederhold, G.	MASCOR					9	83.145	229.772	7.815
Winfield, E.	Center for Materials Research					9	0.377	1.911	0.512
					TOTAL		240.785	678.281	39.988

	Number of Projects	Terminal Access Minutes (K mins)	Pageminutes(K)	Block Storage(K)
CORE RESEARCH PROJECTS	72	1969.938	6163.973	262.117
INDIVIDUAL USER PROJECTS	254	4720.520	17522.459	942.202
OTHER USE (Non-health related use)	32	240.785	678.281	39.988
GRAND TOTAL - RESOURCE USAGE	358	6931.243	24364.713	1244.307

X. MEDICAL CENTER SURVEY

RESULTS OF "SURVEY OF COMPUTER AND DATA PROCESSING NEEDS AT THE STANFORD MEDICAL CENTER -- NOVEMBER, 1970"

A survey was conducted in November and December, 1970, to determine the nature of current and future computing requirements in the Stanford Medical Center. Questionnaire forms were mailed to all department heads along with requests for future distribution within each department. Sixty-three forms were returned and incorporated into the following data.

Responses came from the following sources:

Qty.	Department
13	Hospital Administration
1	Anesthesia
1	Biochemistry
4	Community and Preventive Medicine
3	Genetics
3	Medical Microbiology
8	Medicine
3	Neurology
1	Pathology
4	Pediatrics
4	Psychiatry
5	Radiology
9	Surgery
4	Other Campus Departments
63	TOTAL

Brief summary statements of results are presented below:

1. About one-half of the respondents noted that the most important computer use to them was "general program development" or "routine calculations (super desk calculator)." This indicates that many users needs might be solved by compilers such as BASIC or APL. One third of the respondents felt that "automation of current laboratory of clinical procedures" was of priority "1", "2", or "3" on a scale of "6". About 16% felt that the automation of laboratory or clinical procedures was of highest priority.

2. Of those responding, about 50% were current users of ACME, 20% of Hospital ADP, and 20% of Campus Facility. Ten persons or 16% indicated ownership of a dedicated system.

3. 58% use the PL/ACME language. 21% use no computer language at present or left the question unanswered.

4. 75% indicated plans to replace an existing manual system with an automated system; but the automated one will add new capabilities.

5. 70% indicated the applications were running now; 33% stated that future applications were planned. This was essentially corroborated by another question in which 43 persons stated that programs were already available and 19 indicated programs were not yet available.

6. The single largest limitation on achievement of computing goals was "Your own time or direct knowledge in this field." Other choices available on the form were hardware, system software support, and skilled applications staff.

7. Instrument readings and Laboratory reports were the two most commonly checked sources of data for respondents. These selections were followed by personal interaction and medical records. The items checked by the fewest were doctor's orders, verbal reports from staff, and patient charts.

8. Source of funding data revealed 21 from National Institutes of Health, 12 from Hospital or Medical Center budgets, 5 from private organizations and gifts, 7 from "Other", and 18 who skipped the question without answering.

9. The amount of funding available for computing was left unanswered by 45 of the 63 persons. Of the others, 10 reported $0 to $10,000; 5 reported $11,000 to $20,000; and 3 indicated over $35,000 per year.

10. Twenty responders or roughly one-third reported plans for real-time data acquisition or instrumentation control.

11. Several persons indicated more than one choice on staffing plans. Total responses were 25 to hire own staff, 32 to use staff from central facilites, 2 to use commercial firms, and 18 to "do my own programming".

12. Most respondents felt that computer unavailability could be tolerated for four hours or more. Only 4 persons indicated that downtime on the order of minutes was unacceptable. Slighly more than one-half reported that manual back-up procedures would be essential.

13. In response to the question, "Is your data used to prepare patient billings?" answers were 9--Yes, 48--No, and 6--No response.

14. Nearly three-fourths of the respondents indicated no contribution of information to the patient medical record.

15. Concerning the sharing of information, 36 replies reported sharing of data with less than 5 other persons, while only 9 reported sharing with more than 15 persons.

16. One half of the sample would like to receive the bulk of their data on alphanumeric displays. The second most popular selection of ourput media was printed reports on special forms.

17. 24 persons stated that special precautions would be required for their files due to standard practices, legal, or audit considerations.

18. Access to filed data must require a few minutes or less according to about 70% of the sample.

Analysis of Medical Center Computer Capability Requirements

A more subjective analysis of the survey data written by Tim Coburn 5th year medical student, is presented here.

The problem facing the Stanford Medial Center can be considered as a question of how to best invest roughly two million dollars a year over the next five years in information processing services.

I. The survey has indicated that the requirements or applications for computer capability at the Medical Center fall into eight general categories:

	Requirements	Basic Parameters
1.	Reduction of physiologic data	a,e
2.	Reduction of chemical data	a,d
3.	Machine retreivable storage, "library"	b,e
4.	Super calculating machine	c
5.	Pattern recognition	a,c,e
6.	Accounting and administrative	b,e
7.	Modeling and simulation	b,e
8.	Process control	d

X. MEDICAL CENTER SURVEY

The most basic parameters of computer systems are:

a. high, or rapid input
b. high output
c. sophisticated computational capability
d. fast response time
e. large storage facility

All of these parameters are generally desirable, but they are desirable to different degrees for different applications. The small letters following the eight types of applications denote the more important parameters for the particular type. The parameters to be emphasized are: High input, high output, and large storage capability.

II. Which parameters should a medical center computing capability be designed to emphasize or not to emphasize.

A. Not the super calculating machine applications. These can be handled by the main Campus Facility which is indeed designed for this type of use.

B. Not the pattern recognition applications. Sophisticated types of pattern recognition are still quite esoteric in medical research and treatment. There are other facilities at Stanford where these interests can be pursued.

C. Not modeling and simulation problems. Here again these applications are too sophisticated to merit primary consideration in design of a general system.

D. Not reduction of chemical data. Problems in this area are currently engineering, design of suitable transducers, rather than computer problems.

E. Not process control. These are also engineering problems even though their solution may incorporate computer capability of a fairly trivial nature.

The primary applications for design consideration are therefore: physiologic data reduction, library storage, and accounting.

III. What are reasonable levels of these primary design parameters?

A. Input requirements can be roughly approximated by estimating 20 patients or subjects monitored by 5 sensors at 1 kc per sensor. Total input capability needed = 100 kc bytes continous.

B. Storage capability can be similarly approximated.
100 kc x 60 seconds/minute x 60 minutes/hour x 8 hours x 200 days.
Total storage requirements per year = 5×10^{11} bytes.

C. Output requirements may be estimated by assuming 100 users each capable of absorbing data at 1 kc.
Total output needs = 100 kc bytes continuous.

IV. Cost and feasibility of meeting these needs.

A. The input/output needs could be satisfied by a completely decentralized system of 100 small computers, but this would only provide about 10^8 bytes of storage. The cost would be roughly 40k per computer per year averaged over 5 years. This includes software.
Total cost of completely decentralized system = 4 million/year.

B. The present cost of computer capability is roughly 2 million/year.
1.5 million = ACME and Hospital Data Processing Systems.
.5 million = Small computers and their software.

C. The design problem consists, then of achieving a 2 to 1 reduction in cost over the decentralized system, and an increase in on-line storage capability of at least 10^3.

1) Achieving a 2 to 1 reduction in cost is very largely a problem of software personnel (with engineering support). It is a question of 50 rather than 100 people at an average cost of 20k.
2) Storage capability in the range of 10^{11} bytes is a major problem. Standard IBM tape units are too small by a factor of 1,000. There may be high density optical systems available (see Precision Instuments Unicon).
3) Other hardware design problems should not be too difficult, although an overall system concept may be unfamiliar to many "computer" people.

V. Conclusion.

Centralization of the Medical Center storage facilities could provide a significant gain in cost per unit of data accessible, assuming that the foregoing I/O requirements and size of storage are achieved. However, even with these assumptions, careless design and implementation or external pressures could quickly reduce the net gain to zero or worse. The probability of a net gain from centralization without meeting the above I/O requirements or storage size seems unlikely.

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COMPARISON OF ACME FACILITY 360/50
MEAN TIME BETWEEN FAILURES
FOR JULY 17, 1969 - APRIL 16, 1971
(IN HOURS)

HARDWARE

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Annual Average
1969-1970:	113.3	55.3	25.2	31.3	56.0	167.3	47.4	39.5	58.7	59.6	83.0	34.5	64.3
1970-1971:	72.4	36.4	176.0	362.0	704.0	104.0	218.7	364.0	182.0	*246.6	*246.6	*246.6	*246.6

ALL FAILURES INCL. HARDWARE

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Annual Average
1969-1970:	40.0	33.2	17.7	26.5	48.0	44.0	39.0	25.2	27.0	29.8	60.4	22.6	34.4
1970-1971:	29.0	24.3	54.1	181.0	234.7	38.3	54.7	80.9	66.2	*84.8	*84.8	*84.8	*84.8

CONCLUSION: MTBF for hardware improved by a factor of 4. MTBF for the ACME system for all reasons including hardware failures improved by a factor of 2.5!

Underlined Figures = Best mean time to failure as compared to same month of each year.

* (May - July, 1971) Projected mean time to failure based upon first nine months total of August 1970 through April 1971.